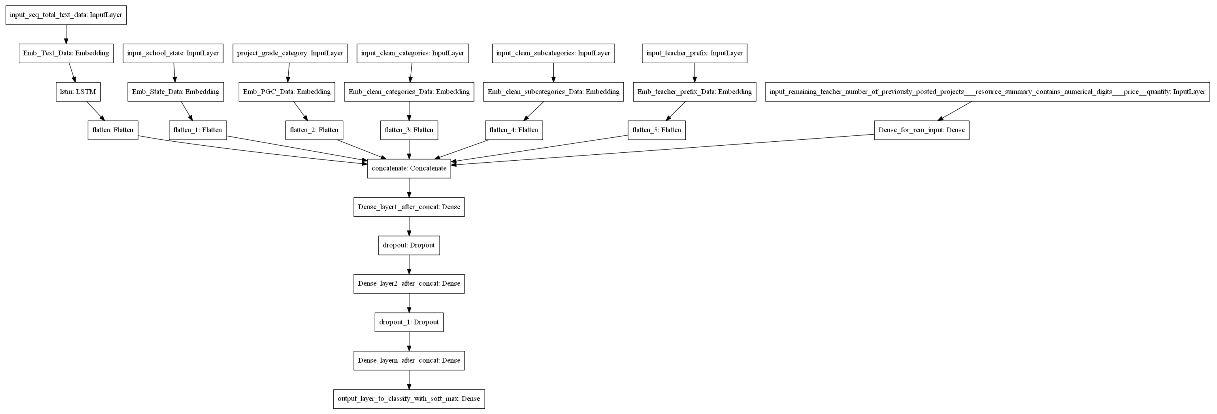
Model 2

In model2 we used same architecture as model1 but filtered words using tfidf.


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

In [0]:
```
import numpy
from keras.datasets import imdb
from keras.models import Sequential
from keras.layers import Dense
from keras.layers import LSTM
from keras.layers.embeddings import Embedding
from keras.preprocessing import sequence
import pandas as pd
from keras.layers import Input, Embedding, LSTM, Dense,Concatenate,Drop
out
from keras.models import Model
import tensorflow as tf
from keras.layers import Input, Embedding, LSTM, Dense,Flatten
from keras.models import Model
import numpy as np
from sklearn.preprocessing import StandardScaler
from numpy import asarray
from numpy import zeros
from keras.layers.normalization import BatchNormalization
from keras.layers import Activation
from keras import regularizers
from keras import optimizers
from keras.optimizers import SGD
from google.colab import drive
from zipfile import ZipFile
from keras.preprocessing.text import Tokenizer
from keras.preprocessing.sequence import pad_sequences
from sklearn.model_selection import train_test_split
import pickle
from keras.layers import LeakyReLU
from sklearn import preprocessing
from keras.layers.normalization import BatchNormalization
from keras.layers import Activation
from keras import regularizers
from keras.optimizers import SGD
import matplotlib.pyplot as plt
from sklearn.metrics import roc_auc_score
```

```
Using TensorFlow backend.
```

The default version of TensorFlow in Colab will soon switch to TensorFlow 2.x.
We recommend you upgrade now or ensure your notebook will continue to use TensorFlow 1.x via the `%tensorflow_version 1.x` magic: more info.

In [0]:
```
from google.colab import drive
drive.mount('/content/drive')
```

```
Drive already mounted at /content/drive; to attempt to forcibly remoun
t, call drive.mount("/content/drive", force_remount=True).
```

In [0]:
```
project_data=pd.read_csv("/content/drive/My Drive/Assignments_DonorsCho
ose_2018/preprocessed_data.csv")
```

In [0]:
```
project_data.head(2)
```

Out[0]:

	school_state	teacher_prefix	project_grade_category	teacher_number_of_previously_p
0	ca	mrs	grades_prek_2	53
1	ut	ms	grades_3_5	4

In [0]:
```
from sklearn.feature_extraction.text import TfidfVectorizer
count_vect = TfidfVectorizer(use_idf=True)
X_train_vect = count_vect.fit_transform(project_data['essay'].values)
project_data['essay'].values.shape
```

Out[0]:
```
(109248,)
```

In [0]:
```
Idf_Values = count_vect.idf_
```

In [0]:
```
print("Maximum IDF value",max(Idf_Values))
print("Minimum IDF value",min(Idf_Values))
```

```
Maximum IDF value 11.908237779037922
Minimum IDF value 1.0077093449425296
```

In [0]:
```
vocab=count_vect.vocabulary_
```

In [0]:
```
lst=[]
for index, item in enumerate(Idf_Values, start=0):
   if(item>10 or item<4):
       lst.append(0)
   else:
       lst.append(1)
```

In [0]:
```
dict_list=[]
for i,j in vocab.items():
    dict_list.append((i,j))
```

In [0]:
```
lst_words=[]
for index, item in enumerate(lst, start=0):
  if(item ==1):
    lst_words.append(dict_list[index][0])
```

In [0]:
```
import pickle
from sklearn.feature_extraction.text import TfidfVectorizer
infile = open('/content/drive/My Drive/final_string','rb')
final_string = pickle.load(infile)
infile.close()
```

In [0]:
```
project_data['cleaned_essay']=final_string
```

In [0]:
```
project_data['essay'].shape
```

Out[0]:
```
(109248,)
```

In [0]:
```
x_train,X_test,y_train,Y_test=train_test_split(project_data,project_dat
a['project_is_approved'],test_size=0.2,random_state=42)
X_train,X_cv,Y_train,Y_cv=train_test_split(x_train,y_train,test_size=0.
2,random_state=42)
```

In [0]:
```
t = Tokenizer()
t.fit_on_texts(X_train['cleaned_essay'])
vocab_size = len(t.word_index) + 1
# integer encode the documents
encoded_docs = t.texts_to_sequences(X_train['cleaned_essay'])
print(encoded_docs)
```

```
# pad documents to a max length of 4 words
#max_length = 4
padded_docs = pad_sequences(encoded_docs, maxlen=300, padding='post')
print(padded_docs)
# load the whole embedding into memory
embeddings_index = dict()
```

```
IOPub data rate exceeded.
The notebook server will temporarily stop sending output
to the client in order to avoid crashing it.
To change this limit, set the config variable
`--NotebookApp.iopub_data_rate_limit`.

Current values:
NotebookApp.iopub_data_rate_limit=1000000.0 (bytes/sec)
NotebookApp.rate_limit_window=3.0 (secs)
```

```
[[ 58  44  76 ...   0   0   0]
 [  1 115 231 ...   0   0   0]
 [  1  17  60 ...   0   0   0]
 ...
 [ 14 527 258 ...   0   0   0]
 [ 65   6  50 ...   0   0   0]
 [ 25   1  25 ...   0   0   0]]
```

In [0]:
```
with open('/content/drive/My Drive/Assignments_DonorsChoose_2018/glove_
vectors', 'rb') as f:
    model = pickle.load(f)
    glove_words =  set(model.keys())

# for train
embedding_matrix = np.zeros((vocab_size, 300))
for word, i in t.word_index.items():
    if word in glove_words:
        embedding_vector = model[word]
        embedding_matrix[i] = embedding_vector
```

In [0]:
```
encoded_docs_test = t.texts_to_sequences(X_test['cleaned_essay'])
```

```
print(encoded_docs_test)
# pad documents to a max length of 4 words
#max_length = 4
padded_docs_test = pad_sequences(encoded_docs_test, maxlen=300, padding
='post')
print(padded_docs_test)
# load the whole embedding into memory
```

```
IOPub data rate exceeded.
The notebook server will temporarily stop sending output
to the client in order to avoid crashing it.
To change this limit, set the config variable
`--NotebookApp.iopub_data_rate_limit`.

Current values:
NotebookApp.iopub_data_rate_limit=1000000.0 (bytes/sec)
NotebookApp.rate_limit_window=3.0 (secs)
```

```
[[   23   883     1 ...     0     0     0]
 [12734   193   434 ...     0     0     0]
 [    6    45  2956 ...     0     0     0]
 ...
 [    1     2    10 ...     0     0     0]
 [    6   385  1799 ...     0     0     0]
 [  621   206   236 ...     0     0     0]]
```

In [0]:
```
encoded_docs_cv = t.texts_to_sequences(X_cv['cleaned_essay'])
print(encoded_docs_cv)

# pad documents to a max length of 4 words
#max_length = 4

padded_docs_cv = pad_sequences(encoded_docs_cv, maxlen=300, padding='po
st')
print(padded_docs_cv)

# load the whole embedding into memory
```

```
IOPub data rate exceeded.
```

```
The notebook server will temporarily stop sending output
to the client in order to avoid crashing it.
To change this limit, set the config variable
`--NotebookApp.iopub_data_rate_limit`.

Current values:
NotebookApp.iopub_data_rate_limit=1000000.0 (bytes/sec)
NotebookApp.rate_limit_window=3.0 (secs)
```

In [0]:

```
# Headline input: meant to receive sequences of 100 integers, between 1
 and 10000.
# Note that we can name any layer by passing it a "name" argument.
Input_Essay = Input(shape=(300,),  name='Input_Essay')

# This embedding layer will encode the input sequence
# into a sequence of dense 512-dimensional vectors.
embedding_essay = Embedding(vocab_size, 300, weights=[embedding_matrix
], input_length=300,trainable = False)(Input_Essay)

# A LSTM will transform the vector sequence into a single vector,
# containing information about the entire sequence

#lr= LeakyReLU(alpha = 0.3)(embedding_essay)
lstm_out = LSTM(300,return_sequences=True)(embedding_essay)
flatten_Essay = Flatten()(lstm_out)
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/ba
ckend/tensorflow_backend.py:541: The name tf.placeholder is deprecated.
Please use tf.compat.v1.placeholder instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/ba
ckend/tensorflow_backend.py:66: The name tf.get_default_graph is deprec
ated. Please use tf.compat.v1.get_default_graph instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/ba
ckend/tensorflow_backend.py:4432: The name tf.random_uniform is depreca
ted. Please use tf.random.uniform instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/ba
```

```
ckend/tensorflow_backend.py:190: The name tf.get_default_session is dep
recated. Please use tf.compat.v1.get_default_session instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/ba
ckend/tensorflow_backend.py:197: The name tf.ConfigProto is deprecated.
Please use tf.compat.v1.ConfigProto instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/ba
ckend/tensorflow_backend.py:203: The name tf.Session is deprecated. Ple
ase use tf.compat.v1.Session instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/ba
ckend/tensorflow_backend.py:207: The name tf.global_variables is deprec
ated. Please use tf.compat.v1.global_variables instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/ba
ckend/tensorflow_backend.py:216: The name tf.is_variable_initialized is
deprecated. Please use tf.compat.v1.is_variable_initialized instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/ba
ckend/tensorflow_backend.py:223: The name tf.variables_initializer is d
eprecated. Please use tf.compat.v1.variables_initializer instead.
```

School_State

In [0]:

```
le_school_state = preprocessing.LabelEncoder()
Label_encoded_school_state=le_school_state.fit_transform(X_train['schoo
l_state'])
Label_encoded_school_state_cv=le_school_state.transform(X_cv['school_st
ate'])
Label_encoded_school_state_test=le_school_state.transform(X_test['schoo
l_state'])
```

In [0]:

```
padded_docs_school_state=Label_encoded_school_state
padded_docs_cv_school_state=Label_encoded_school_state_cv
```

```
padded_docs_test_school_state=Label_encoded_school_state_test
```

In [0]:
```
vocab_size_school_state = le_school_state.classes_
vocab_size_school_state_len=len(vocab_size_school_state)
```

In [0]:
```
Input_School_State_1 = Input(shape=(1,),  name='Input_School_State')

embedding_school_state_1=Embedding(vocab_size_school_state_len, 32, inp
ut_length=1)(Input_School_State_1)
flatten_School_State_1 = Flatten()(embedding_school_state_1)
```

teacher_prefix

In [0]:
```
le_teacher_prefix = preprocessing.LabelEncoder()
Label_encoded_teacher_prefix=le_teacher_prefix.fit_transform(X_train['t
eacher_prefix'])
Label_encoded_teacher_prefix_cv=le_teacher_prefix.transform(X_cv['teach
er_prefix'])
Label_encoded_teacher_prefix_test=le_teacher_prefix.transform(X_test['t
eacher_prefix'])
```

In [0]:
```
padded_docs_teacher_prefix=Label_encoded_teacher_prefix
padded_docs_cv_teacher_prefix=Label_encoded_teacher_prefix_cv
padded_docs_test_teacher_prefix=Label_encoded_teacher_prefix_test
```

In [0]:
```
vocab_size_teacher_prefix_len=len(le_teacher_prefix.classes_)
```

In [0]:
```
Input_teacher_prefix_1 = Input(shape=(1,),  name='Input_teacher_prefix_
1')

embedding_teacher_prefix_1=Embedding(vocab_size_teacher_prefix_len, 32,
 input_length=1)(Input_teacher_prefix_1)
flatten_teacher_prefix_1 = Flatten()(embedding_teacher_prefix_1)
```

grade_category

In [0]:
```
le_grade_category = preprocessing.LabelEncoder()
Label_encoded_grade_category=le_grade_category.fit_transform(X_train['project_grade_category'])
```

In [0]:
```
Label_encoded_grade_category_cv=le_grade_category.transform(X_cv['project_grade_category'])
```

In [0]:
```
Label_encoded_grade_category_test=le_grade_category.transform(X_test['project_grade_category'])
vocab_size_grade_category_len=len(le_grade_category.classes_)
```

In [0]:
```
padded_docs_project_grade_category=Label_encoded_grade_category
padded_docs_cv_project_grade_category=Label_encoded_grade_category_cv
padded_docs_test_project_grade_category=Label_encoded_grade_category_test
```

In [0]:
```
Input_grade_category_1 = Input(shape=(1,),  name='Input_grade_category_1')
embedding_grade_category_1=Embedding(vocab_size_grade_category_len, 32, input_length=1)(Input_grade_category_1)
flatten_grade_category_1 = Flatten()(embedding_grade_category_1)
```

clean_categories

In [0]:
```
le_clean_categories = preprocessing.LabelEncoder()
Label_encoded_clean_categories=le_clean_categories.fit_transform(X_train['clean_categories'])
```

In [0]:
```
Label_encoded_clean_categories_cv=le_clean_categories.transform(X_cv['clean_categories'])
```

In [0]:
```
Label_encoded_clean_categories_test=le_clean_categories.transform(X_tes
t['clean_categories'])
```

In [0]:
```
padded_docs_clean_categories=Label_encoded_clean_categories
padded_docs_cv_clean_categories=Label_encoded_clean_categories_cv
padded_docs_test_clean_categories=Label_encoded_clean_categories_test
```

In [0]:
```
vocab_size_grade_category_len=len(le_clean_categories.classes_)
```

In [0]:
```
Input_clean_categories_1 = Input(shape=(1,),  name='Input_clean_categor
ies_1')

embedding_clean_categories_1=Embedding(vocab_size_grade_category_len, 3
2, input_length=1)(Input_clean_categories_1)
flatten_clean_categories_1 = Flatten()(embedding_clean_categories_1)
```

clean_subcategories

In [0]:
```
clean_subcategories_dict=dict()

i=1

for sent in X_train['clean_subcategories']:
    if sent not in clean_subcategories_dict:
        clean_subcategories_dict[sent]=i
        i=i+1

vocab_size_clean_subcategories=len(clean_subcategories_dict)
```

In [0]:
```
Label_clean_subcategories=[]
for sent in X_train['clean_subcategories']:
    try:
        Label_clean_subcategories.append(clean_subcategories_dict[sent
])
```

```
    except:
        Label_clean_subcategories.append(0)

padded_docs_clean_subcategories = Label_clean_subcategories

padded_docs_clean_subcategories = np.asarray(padded_docs_clean_subcateg
ories)
```

In [0]:
```
#Label_encoded_clean_subcategories_test
padded_docs_cv_clean_subcategories=[]
Label_encoded_clean_subcategories_cv=[]
for sent in X_cv['clean_subcategories']:
    try:
        Label_encoded_clean_subcategories_cv.append(clean_subcategories
_dict[sent])

    except:
        Label_encoded_clean_subcategories_cv.append(0)

padded_docs_cv_clean_subcategories=Label_encoded_clean_subcategories_cv
padded_docs_cv_clean_subcategories = np.asarray(padded_docs_cv_clean_su
bcategories)
```

In [0]:
```
padded_docs_test_clean_subcategories=[]
Label_encoded_clean_subcategories_test=[]
for sent in X_test['clean_subcategories']:
    try:
        Label_encoded_clean_subcategories_test.append(clean_subcategori
es_dict[sent])

    except:
        Label_encoded_clean_subcategories_test.append(0)


padded_docs_test_clean_subcategories=Label_encoded_clean_subcategories_
test
```

In [0]:
```
#padded_docs_clean_subcategories = np.asarray(padded_docs_clean_subcate
gories)
padded_docs_test_clean_subcategories=np.asarray(padded_docs_test_clean_
subcategories)
```

In [0]:
```
Input_clean_subcategories_1 = Input(shape=(1,), name='Input_clean_subca
tegories_1')

embedding_clean_subcategories_1=Embedding(vocab_size_clean_subcategorie
s, 28, input_length=1)(Input_clean_subcategories_1)
flatten_clean_subcategories_1 = Flatten()(embedding_clean_subcategories
_1)
```

teacher_number_of_previously_posted_projects

In [0]:
```
rem_input_train = np.concatenate((X_train['price'].values.reshape(-1,1
),X_train['teacher_number_of_previously_posted_projects'].values.reshap
e(-1,1)), axis=1)
rem_input_cv =    np.concatenate((X_cv['price'].values.reshape(-1,1),X_
cv['teacher_number_of_previously_posted_projects'].values.reshape(-1,1
)), axis=1)
rem_input_test = np.concatenate((X_test['price'].values.reshape(-1,1),X
_test['teacher_number_of_previously_posted_projects'].values.reshape(-1
,1)), axis=1)
```

In [0]:
```
#from sklearn.preprocessing import StandardScalar
mms = StandardScaler().fit(rem_input_train)
rem_input_train_norm = mms.transform(rem_input_train)
rem_input_cv_norm = mms.transform(rem_input_cv)
rem_input_test_norm = mms.transform(rem_input_test)
```

In [0]:
```
remaining_input = Input(shape=(2,), name='remaining_input')
dense_1 = Dense(1, activation='relu',kernel_initializer="uniform")(rema
ining_input)
```

In [0]:
```
def auc(y_true,y_pred):
    return tf.py_func(roc_auc_score, (y_true, y_pred), tf.double)
```

In [0]:
```
x = Concatenate()([flatten_Essay, flatten_School_State_1,flatten_teacher_prefix_1,flatten_grade_category_1,flatten_clean_categories_1,flatten_clean_subcategories_1,dense_1])
```

In [0]:
```
x = Dense(128, activation='relu',kernel_initializer="he_normal",kernel_regularizer=regularizers.l2(0.001))(x)
x=  Dropout(0.5)(x)


x = Dense(64, activation='relu',kernel_initializer="he_normal",kernel_regularizer=regularizers.l2(0.001))(x)
x=  Dropout(0.5)(x)
x = BatchNormalization()(x)

x = Dense(64, activation='relu',kernel_initializer="he_normal",kernel_regularizer=regularizers.l2(0.001))(x)
x=  Dropout(0.5)(x)

main_output = Dense(1, activation='sigmoid', name='main_output')(x)
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:4479: The name tf.truncated_normal is deprecated. Please use tf.random.truncated_normal instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:148: The name tf.placeholder_with_default is deprecated. Please use tf.compat.v1.placeholder_with_default instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:3733: calling dropout (from tensorflow.python.ops.nn_ops) with keep_prob is deprecated and will be removed in a future version.
Instructions for updating:
Please use `rate` instead of `keep_prob`. Rate should be set to `rate = 1 - keep_prob`.
```

In [0]:
```
learning_rate = 0.001
decay_rate = learning_rate / 10
#optimizers.Adam,optimizers.Nadam,optimizers.RMSprop
#from keras.optimizers import Adam
model2 = Model(inputs=[Input_Essay,Input_School_State_1,Input_teacher_p
refix_1,Input_grade_category_1,Input_clean_categories_1,Input_clean_sub
categories_1,remaining_input], outputs=[main_output])
#adam = optimizers.Adam(lr=0.001, beta_1=0.9, beta_2=0.999, amsgrad=Fal
se)
#lr=0.01,
#decay=decay_rate
adam = optimizers.Adam(lr=0.001)
model2.compile(loss="binary_crossentropy", optimizer=adam, metrics=[auc
])
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/op
timizers.py:793: The name tf.train.Optimizer is deprecated. Please use
tf.compat.v1.train.Optimizer instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/ba
ckend/tensorflow_backend.py:3657: The name tf.log is deprecated. Please
use tf.math.log instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorfl
ow_core/python/ops/nn_impl.py:183: where (from tensorflow.python.ops.ar
ray_ops) is deprecated and will be removed in a future version.
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where
WARNING:tensorflow:From <ipython-input-51-1ce08cb8f48c>:2: py_func (fro
m tensorflow.python.ops.script_ops) is deprecated and will be removed i
n a future version.
Instructions for updating:
tf.py_func is deprecated in TF V2. Instead, there are two
    options available in V2.
    - tf.py_function takes a python function which manipulates tf eager
    tensors instead of numpy arrays. It's easy to convert a tf eager te
nsor to
    an ndarray (just call tensor.numpy()) but having access to eager te
nsors
    means `tf.py_function`s can use accelerators such as GPUs as well a
```

```
s
    being differentiable using a gradient tape.
    - tf.numpy_function maintains the semantics of the deprecated tf.py
_func
    (it is not differentiable, and manipulates numpy arrays). It drops
the
    stateful argument making all functions stateful.
```

In [0]:
```
model2.summary()
```

```
Model: "model_1"
______________________________________________________________________
___________________________
Layer (type)                    Output Shape         Param #     Connec
ted to
======================================================================
===========================
Input_Essay (InputLayer)        (None, 300)          0


______________________________________________________________________
___________________________
embedding_1 (Embedding)         (None, 300, 300)     8628900     Input_
Essay[0][0]

______________________________________________________________________
___________________________
Input_School_State (InputLayer) (None, 1)            0


______________________________________________________________________
___________________________
Input_teacher_prefix_1 (InputLa (None, 1)            0


______________________________________________________________________
___________________________
Input_grade_category_1 (InputLa (None, 1)            0


______________________________________________________________________
___________________________
Input_clean_categories_1 (Input (None, 1)            0
________________________________________________________________________
___________________________
Input_clean_subcategories_1 (In (None, 1)            0


________________________________________________________________________
___________________________
lstm_1 (LSTM)                   (None, 300, 300)     721200      embedd
ing_1[0][0]

________________________________________________________________________
___________________________
embedding_2 (Embedding)         (None, 1, 32)        1632        Input_
School_State[0][0]

________________________________________________________________________
___________________________
embedding_3 (Embedding)         (None, 1, 32)        160         Input_
teacher_prefix_1[0][0]

________________________________________________________________________
___________________________
embedding_4 (Embedding)         (None, 1, 32)        128         Input_
grade_category_1[0][0]

________________________________________________________________________
___________________________
embedding_5 (Embedding)         (None, 1, 32)        1632        Input_
clean_categories_1[0][0]

________________________________________________________________________
___________________________
embedding_6 (Embedding)         (None, 1, 28)        10864       Input_
clean_subcategories_1[0][0]

________________________________________________________________________
___________________________
remaining_input (InputLayer)    (None, 2)            0


________________________________________________________________________
___________________________
flatten_1 (Flatten)             (None, 90000)        0           lstm_1
[0][0]

________________________________________________________________________
___________________________
```

```
flatten_2 (Flatten)             (None, 32)          0           embedd
ing_2[0][0]
__________________________________________________________________________
_____________________________
flatten_3 (Flatten)             (None, 32)          0           embedd
ing_3[0][0]
__________________________________________________________________________
_____________________________
flatten_4 (Flatten)             (None, 32)          0           embedd
ing_4[0][0]
__________________________________________________________________________
_____________________________
flatten_5 (Flatten)             (None, 32)          0           embedd
ing_5[0][0]
__________________________________________________________________________
_____________________________
flatten_6 (Flatten)             (None, 28)          0           embedd
ing_6[0][0]
__________________________________________________________________________
_____________________________
dense_1 (Dense)                 (None, 1)           3           remain
ing_input[0][0]
__________________________________________________________________________
_____________________________
concatenate_1 (Concatenate)     (None, 90157)       0           flatte
n_1[0][0]
                                                                flatte
n_2[0][0]
                                                                flatte
n_3[0][0]
                                                                flatte
n_4[0][0]
                                                                flatte
n_5[0][0]
                                                                flatte
n_6[0][0]
                                                                dense_
1[0][0]
__________________________________________________________________________
```

```
___________________________
dense_2 (Dense)                 (None, 128)          11540224    concat
enate_1[0][0]

________________________________________________________________________
___________________________
dropout_1 (Dropout)             (None, 128)          0           dense_
2[0][0]

________________________________________________________________________
___________________________
dense_3 (Dense)                 (None, 64)           8256        dropou
t_1[0][0]

________________________________________________________________________
___________________________
dropout_2 (Dropout)             (None, 64)           0           dense_
3[0][0]

________________________________________________________________________
___________________________
batch_normalization_1 (BatchNor (None, 64)           256         dropou
t_2[0][0]

________________________________________________________________________
___________________________
dense_4 (Dense)                 (None, 64)           4160        batch_
normalization_1[0][0]

________________________________________________________________________
___________________________
dropout_3 (Dropout)             (None, 64)           0           dense_
4[0][0]

________________________________________________________________________
___________________________
main_output (Dense)             (None, 1)            65          dropou
t_3[0][0]
========================================================================
===========================
Total params: 20,917,480
Trainable params: 12,288,452
Non-trainable params: 8,629,028

________________________________________________________________________
___________________________
```

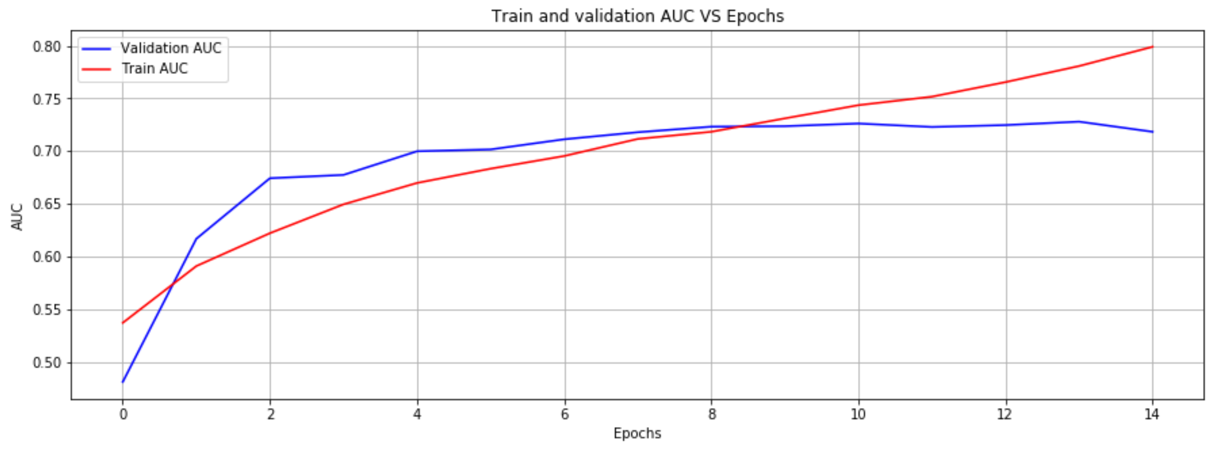
```
In [0]: model_2=model2.fit([padded_docs, padded_docs_school_state,padded_docs_t
eacher_prefix,padded_docs_project_grade_category,padded_docs_clean_cate
gories,padded_docs_clean_subcategories,rem_input_train_norm],Y_train,ep
ochs=15 ,batch_size=1002,validation_data=([padded_docs_cv,padded_docs_c
v_school_state,padded_docs_cv_teacher_prefix,padded_docs_cv_project_gra
de_category,padded_docs_cv_clean_categories,padded_docs_cv_clean_subcat
egories,rem_input_cv_norm], Y_cv))
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/ba
ckend/tensorflow_backend.py:1033: The name tf.assign_add is deprecated.
Please use tf.compat.v1.assign_add instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/ba
ckend/tensorflow_backend.py:1020: The name tf.assign is deprecated. Ple
ase use tf.compat.v1.assign instead.

Train on 69918 samples, validate on 17480 samples
Epoch 1/15
69918/69918 [==============================] - 40s 579us/step - loss:
0.9948 - auc: 0.5369 - val_loss: 0.8197 - val_auc: 0.4808
Epoch 2/15
69918/69918 [==============================] - 38s 546us/step - loss:
0.7457 - auc: 0.5908 - val_loss: 0.6712 - val_auc: 0.6167
Epoch 3/15
69918/69918 [==============================] - 38s 546us/step - loss:
0.6384 - auc: 0.6220 - val_loss: 0.6287 - val_auc: 0.6742
Epoch 4/15
69918/69918 [==============================] - 38s 544us/step - loss:
0.5784 - auc: 0.6494 - val_loss: 0.5695 - val_auc: 0.6773
Epoch 5/15
69918/69918 [==============================] - 38s 545us/step - loss:
0.5448 - auc: 0.6697 - val_loss: 0.5647 - val_auc: 0.6998
Epoch 6/15
69918/69918 [==============================] - 38s 545us/step - loss:
0.5183 - auc: 0.6833 - val_loss: 0.5344 - val_auc: 0.7015
Epoch 7/15
69918/69918 [==============================] - 38s 545us/step - loss:
0.4930 - auc: 0.6953 - val_loss: 0.5035 - val_auc: 0.7112
Epoch 8/15
69918/69918 [==============================] - 38s 544us/step - loss:
```

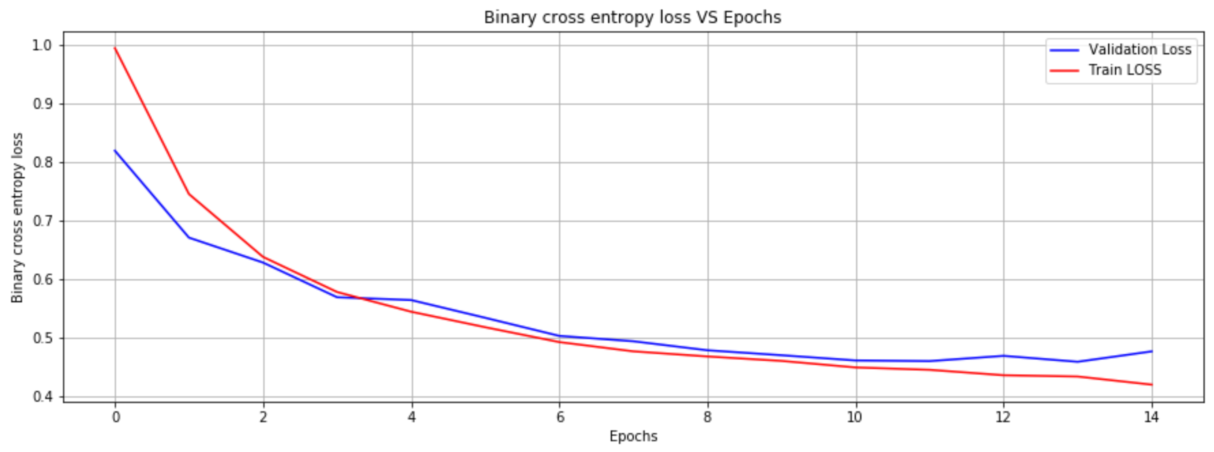
```
0.4771 - auc: 0.7115 - val_loss: 0.4944 - val_auc: 0.7178

Epoch 9/15
69918/69918 [==============================] - 38s 544us/step - loss:
0.4684 - auc: 0.7183 - val_loss: 0.4790 - val_auc: 0.7231
Epoch 10/15
69918/69918 [==============================] - 38s 544us/step - loss:
0.4608 - auc: 0.7310 - val_loss: 0.4705 - val_auc: 0.7236
Epoch 11/15
69918/69918 [==============================] - 38s 542us/step - loss:
0.4497 - auc: 0.7435 - val_loss: 0.4616 - val_auc: 0.7261
Epoch 12/15
69918/69918 [==============================] - 38s 544us/step - loss:
0.4456 - auc: 0.7516 - val_loss: 0.4605 - val_auc: 0.7229
Epoch 13/15
69918/69918 [==============================] - 38s 543us/step - loss:
0.4364 - auc: 0.7654 - val_loss: 0.4695 - val_auc: 0.7246
Epoch 14/15
69918/69918 [==============================] - 38s 547us/step - loss:
0.4342 - auc: 0.7807 - val_loss: 0.4593 - val_auc: 0.7279
Epoch 15/15
69918/69918 [==============================] - 38s 547us/step - loss:
0.4203 - auc: 0.7990 - val_loss: 0.4771 - val_auc: 0.7183
```

In [0]:
```
model2_history=model2.predict([padded_docs_test,padded_docs_test_school
_state,padded_docs_test_teacher_prefix,padded_docs_test_project_grade_c
ategory,padded_docs_test_clean_categories,padded_docs_test_clean_subcat
egories,rem_input_test_norm])
```

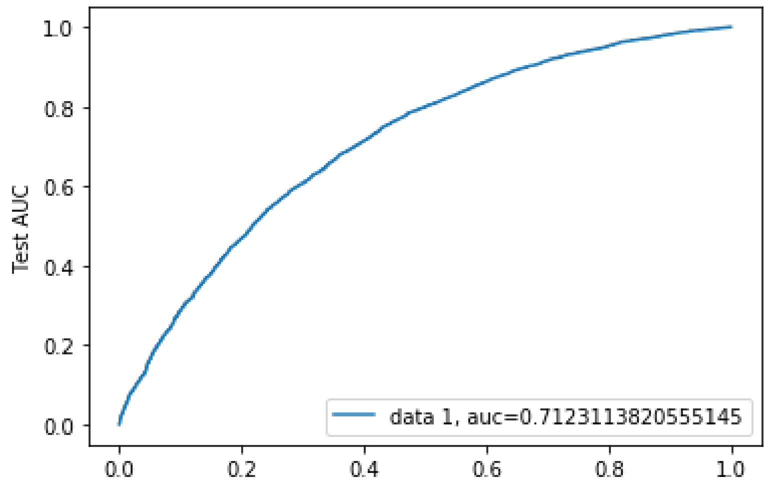
In [0]:
```
x = list(range(15))
vy = model_2.history['auc']
ty = model_2.history['val_auc']
plt.figure(figsize=(15,5))
plt.plot(x, ty, 'b', label="Validation AUC")
plt.plot(x, vy, 'r', label="Train AUC")
plt.xlabel('Epochs')
plt.ylabel('AUC')
plt.title('\nTrain and validation AUC VS Epochs')
plt.legend()
plt.grid()
plt.show()
```



In [0]:
```
import matplotlib.pyplot as plt

x = list(range(15))
vy = model_2.history['loss']
ty = model_2.history['val_loss']
plt.figure(figsize=(15,5))
plt.plot(x, ty, 'b', label="Validation Loss")
plt.plot(x, vy, 'r', label="Train LOSS")
plt.xlabel('Epochs')
plt.ylabel('Binary cross entropy loss')
plt.title('\nBinary cross entropy loss VS Epochs')
plt.legend()
plt.grid()
plt.show()
```



In [0]:
```
from sklearn.metrics import roc_curve
from sklearn.metrics import roc_auc_score
fpr, tpr, _ = roc_curve(Y_test,  model2_history)
auc = roc_auc_score(Y_test, model2_history)
plt.plot(fpr,tpr,label="data 1, auc="+str(auc))
plt.legend(loc=4)
#plt.xlabel('Epochs')
plt.ylabel('Test AUC')
plt.show()
```


Test AUC
data 1, auc=0.7123113820555145