In [ ]:

```
import numpy as np
import pandas as pd
import pickle
from statistics import mode
import nltk
from nltk import word_tokenize
from nltk.stem import LancasterStemmer
nltk.download('wordnet')
nltk.download('stopwords')
nltk.download('punkt')
```

```
[nltk_data] Downloading package wordnet to /root/nltk_dat
a...
[nltk_data]   Package wordnet is already up-to-date!
[nltk_data] Downloading package stopwords to /root/nltk_dat
a...
[nltk_data]   Package stopwords is already up-to-date!
[nltk_data] Downloading package punkt to /root/nltk_data...
[nltk_data]   Package punkt is already up-to-date!
```

Out[ ]:

```
True
```

In [ ]:

```
from nltk.corpus import stopwords
```

In [ ]:

```
from tensorflow.keras.models import Model
```

In [ ]:

```
from tensorflow.keras import models
from tensorflow.keras import backend as K
```

In [ ]:

```
from tensorflow.keras.preprocessing.sequence import pad_sequences
from tensorflow.keras.preprocessing.text import Tokenizer
from tensorflow.keras.utils import plot_model
from tensorflow.keras.layers import Input, LSTM, Embedding, Dense, Conca
tenate, Attention
from sklearn.model_selection import train_test_split
from bs4 import BeautifulSoup
```

In [ ]:

```
import tensorflow as tf
```

In [ ]:

```
df=pd.read_csv("/content/drive/MyDrive/data/Reviews.csv", nrows=100000)
```

In [ ]:

```
df.head()
```

Out[ ]:

| | Id | ProductId | UserId | ProfileName | HelpfulnessNumerator | Help |
|---|---|---|---|---|---|---|
| **0** | 1 | B001E4KFG0 | A3SGXH7AUHU8GW | delmartian | 1 | |
| **1** | 2 | B00813GRG4 | A1D87F6ZCVE5NK | dll pa | 0 | |
| **2** | 3 | B000LQOCH0 | ABXLMWJIXXAIN | Natalia Corres "Natalia Corres" | 1 | |
| **3** | 4 | B000UA0QIQ | A395BORC6FGVXV | Karl | 3 | |
| **4** | 5 | B006K2ZZ7K | A1UQRSCLF8GW1T | Michael D. Bigham "M. Wassir" | 0 | |

In [ ]:

```
# drop the duplicate and na values from the records
df.drop_duplicates(subset=['Text'], inplace=True)
```

In [ ]:

```
df.dropna(axis=0, inplace=True)
```

In [ ]:

```
input_data = df.loc[:, 'Text']
target_data = df.loc[:, 'Summary']
```

In [ ]:

```
input_data.head()
```

Out[ ]:

```
0    I have bought several of the Vitality canned d...
1    Product arrived labeled as Jumbo Salted Peanut...
2    This is a confection that has been around a fe...
3    If you are looking for the secret ingredient i...
4    Great taffy at a great price.  There was a wid...
Name: Text, dtype: object
```

In [ ]:

```
input_texts = []
target_texts = []
input_words = []
target_words = []
```

In [ ]:

```
contractions = pickle.load(open(
    "/content/drive/MyDrive/text-summarization-ml-project/contractions.pkl", "rb"))['contractions']
```

In [ ]:

```
# initialize stop words and LancasterStemmer
stop_words = set(stopwords.words('english'))
stemm = LancasterStemmer()
```

In [ ]:

```
def clean(texts, src):
    # remove the html tags
    texts = BeautifulSoup(texts, "lxml").text
    # tokenize the text into words
    words = word_tokenize(texts.lower())
    # filter words which contains \
    # integers or their length is less than or equal to 3
    words = list(filter(lambda w: (w.isalpha() and len(w) >= 3), words))
    # contraction file to expand shortened words
    words = [contractions[w] if w in contractions else w for w in words]
    # stem the words to their root word and filter stop words
    if src == "inputs":
        words = [stemm.stem(w) for w in words if w not in stop_words]
    else:
        words = [w for w in words if w not in stop_words]
    return words
```

In [ ]:

```
# pass the input records and taret records
for in_txt, tr_txt in zip(input_data, target_data):
    in_words = clean(in_txt, "inputs")
    input_texts += [' '.join(in_words)]
    input_words += in_words
    # add 'sos' at start and 'eos' at end of text
    tr_words = clean("sos "+tr_txt+" eos", "target")
    target_texts += [' '.join(tr_words)]
    target_words += tr_words
```

In [ ]:

```
# store only unique words from input and target list of words
input_words = sorted(list(set(input_words)))
target_words = sorted(list(set(target_words)))
num_in_words = len(input_words)  # total number of input words
num_tr_words = len(target_words)  # total number of target words

# get the length of the input and target texts which appears most often
max_in_len = mode([len(i) for i in input_texts])
max_tr_len = mode([len(i) for i in target_texts])
```

In [ ]:

```
print("number of input words : ", num_in_words)
print("number of target words : ", num_tr_words)
print("maximum input length : ", max_in_len)
print("maximum target length : ", max_tr_len)
```

```
number of input words :  32198
number of target words :  14170
maximum input length :  74
maximum target length :  17
```

In [ ]:

```
#split the input and target text into 80:20 ratio or testing size of 2
0%.
x_train,x_test,y_train,y_test=train_test_split(input_texts,target_texts,
test_size=0.2,random_state=0)
```

In [ ]:

```
#train the tokenizer with all the words
in_tokenizer = Tokenizer()
in_tokenizer.fit_on_texts(x_train)
tr_tokenizer = Tokenizer()
tr_tokenizer.fit_on_texts(y_train)
```

In [ ]:

```
# convert text into sequence of integers
# where the integer will be the index of that word
x_train = in_tokenizer.texts_to_sequences(x_train)
y_train = tr_tokenizer.texts_to_sequences(y_train)
```

In [ ]:

```
#pad array of 0's if the length is less than the maximum length
en_in_data= pad_sequences(x_train,  maxlen=max_in_len, padding='post')
dec_data= pad_sequences(y_train,  maxlen=max_tr_len, padding='post')
```

In [ ]:

```
# decoder input data will not include the last word
# i.e. 'eos' in decoder input data
dec_in_data = dec_data[:, :-1]
# decoder target data will be one time step ahead as it will not include
# the first word i.e 'sos'
dec_tr_data = dec_data.reshape(len(dec_data), max_tr_len, 1)[:, 1:]
```

In [ ]:

```
K.clear_session()
latent_dim = 500
```

In [ ]:

```
# create input object of total number of input words
en_inputs = Input(shape=(max_in_len,))
en_embedding = Embedding(num_in_words+1, latent_dim)(en_inputs)
```

In [ ]:

```
#create 3 stacked LSTM layer with the shape of hidden dimension
#LSTM 1
en_lstm1= LSTM(latent_dim, return_state=True, return_sequences=True)
en_outputs1, state_h1, state_c1= en_lstm1(en_embedding)

#LSTM2
en_lstm2= LSTM(latent_dim, return_state=True, return_sequences=True)
en_outputs2, state_h2, state_c2= en_lstm2(en_outputs1)

#LSTM3
en_lstm3= LSTM(latent_dim,return_sequences=True,return_state=True)
en_outputs3 , state_h3 , state_c3= en_lstm3(en_outputs2)
```

In [ ]:

```
# encoder states
en_states = [state_h3, state_c3]

# Decoder.
dec_inputs = Input(shape=(None,))
dec_emb_layer = Embedding(num_tr_words+1, latent_dim)
dec_embedding = dec_emb_layer(dec_inputs)
```

In [ ]:

```
#initialize decoder's LSTM layer with the output states of encoder
dec_lstm = LSTM(latent_dim, return_sequences=True, return_state=True)
dec_outputs, *_ = dec_lstm(dec_embedding,initial_state=en_states)
```

In [ ]:

```
#Attention layer
attention =Attention()
attn_out = attention([dec_outputs,en_outputs3])
```

In [ ]:

```
#Concatenate the attention output with the decoder ouputs
merge=Concatenate(axis=-1, name='concat_layer1')([dec_outputs,attn_out])
```

In [ ]:

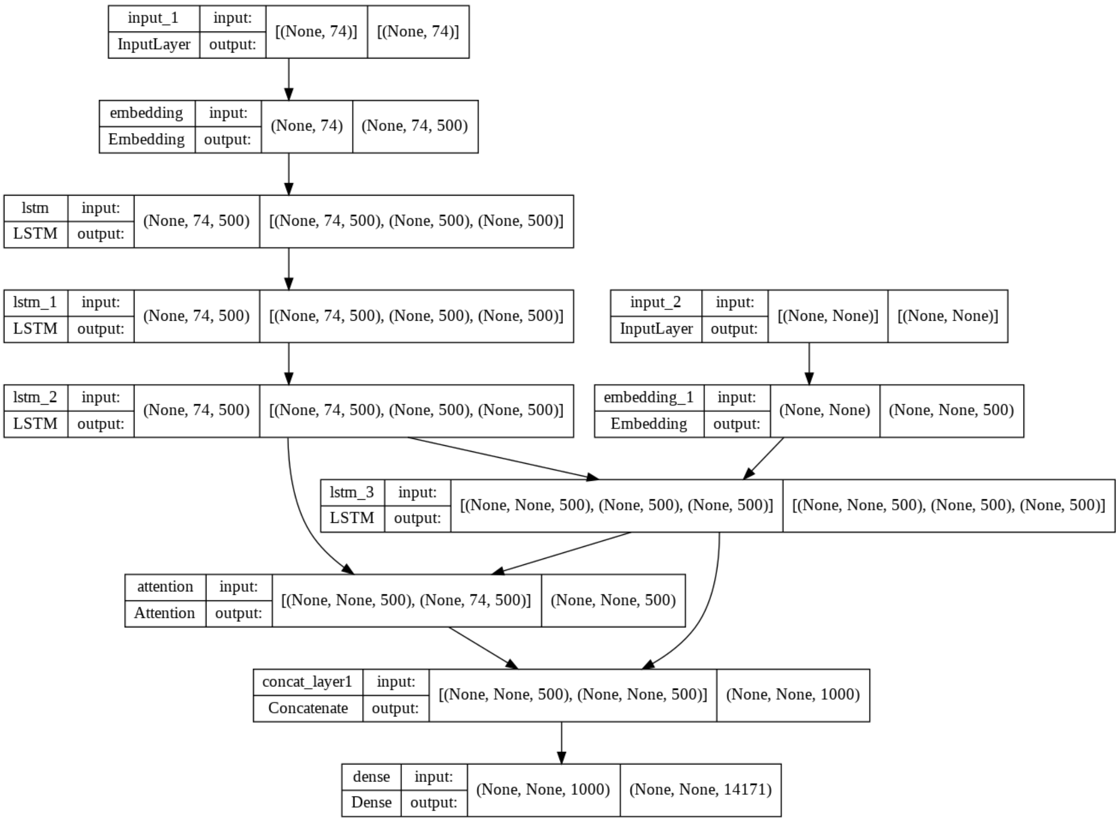
```
# Dense layer (output layer)
dec_dense = Dense(num_tr_words+1, activation='softmax')
dec_outputs = dec_dense(merge)
```

In [ ]:

```
# Mode class and model summary
model = Model([en_inputs, dec_inputs], dec_outputs)
model.summary()
plot_model(model, to_file='model_plot.png',
           show_shapes=True, show_layer_names=True)
```

```
Model: "model"
____________________________________________________________
______________________________________
 Layer (type)                    Output Shape         Param # 
Connected to                     
============================================================
======================================
 input_1 (InputLayer)            [(None, 74)]         0           
[]                               
                                                                                                  
 embedding (Embedding)           (None, 74, 500)      1609950
0    ['input_1[0][0]']                
                                                                                                  
 lstm (LSTM)                     [(None, 74, 500),    2002000     
['embedding[0][0]']              
                                  (None, 500),                                                    
                                  (None, 500)]                                                    
                                                                                                  
 input_2 (InputLayer)            [(None, None)]       0           
[]                               
                                                                                                  
 lstm_1 (LSTM)                   [(None, 74, 500),    2002000     
['lstm[0][0]']                   
                                  (None, 500),                                                    
                                  (None, 500)]                                                    
                                                                                                  
 embedding_1 (Embedding)         (None, None, 500)    7085500     
['input_2[0][0]']                
                                                                                                  
 lstm_2 (LSTM)                   [(None, 74, 500),    2002000     
['lstm_1[0][0]']                 
                                  (None, 500),                                                    
                                  (None, 500)]                                                    
                                                                                                  
 lstm_3 (LSTM)                   [(None, None, 500),  2002000     
['embedding_1[0][0]',            
                                  (None, 500),                     
'lstm_2[0][1]',                  
                                  (None, 500)]                     
'lstm_2[0][2]']                  
                                                                                                  
 attention (Attention)           (None, None, 500)    0           
['lstm_3[0][0]',                 
                                                                   
'lstm_2[0][0]']                  
                                                                                                  
 concat_layer1 (Concatenate)     (None, None, 1000)   0           
['lstm_3[0][0]',                 
                                                                   
'attention[0][0]']               
                                                                                                  
 dense (Dense)                   (None, None, 14171)  1418517
1    ['concat_layer1[0][0]']          
                                                                                                  
============================================================
======================================
Total params: 45,378,171
Trainable params: 45,378,171
Non-trainable params: 0
```

Out[ ]:


input_1 | InputLayer | input: | output: | [(None, 74)] | [(None, 74)]
embedding | Embedding | input: | output: | (None, 74) | (None, 74, 500)
lstm | LSTM | input: | output: | (None, 74, 500) | [(None, 74, 500), (None, 500), (None, 500)]
lstm_1 | LSTM | input: | output: | (None, 74, 500) | [(None, 74, 500), (None, 500), (None, 500)]
input_2 | InputLayer | input: | output: | [(None, None)] | [(None, None)]
lstm_2 | LSTM | input: | output: | (None, 74, 500) | [(None, 74, 500), (None, 500), (None, 500)]
embedding_1 | Embedding | input: | output: | (None, None) | (None, None, 500)
lstm_3 | LSTM | input: | output: | [(None, None, 500), (None, 500), (None, 500)] | [(None, None, 500), (None, 500), (None, 500)]
attention | Attention | input: | output: | [(None, None, 500), (None, 74, 500)] | (None, None, 500)
concat_layer1 | Concatenate | input: | output: | [(None, None, 500), (None, None, 500)] | (None, None, 1000)
dense | Dense | input: | output: | (None, None, 1000) | (None, None, 14171)

In [ ]:

```
model.compile(
    optimizer="rmsprop", loss="sparse_categorical_crossentropy", metrics
=["accuracy"])
model.fit(
    [en_in_data, dec_in_data],
    dec_tr_data,
    batch_size=512,
    epochs=10,
    validation_split=0.1,
)
```

```
Epoch 1/10
125/125 [==============================] - 99s 710ms/step -
loss: 1.5334 - accuracy: 0.8106 - val_loss: 1.2828 - val_acc
uracy: 0.8343
Epoch 2/10
125/125 [==============================] - 101s 805ms/step -
loss: 1.2414 - accuracy: 0.8342 - val_loss: 1.2187 - val_acc
uracy: 0.8368
Epoch 3/10
125/125 [==============================] - 101s 810ms/step -
loss: 1.1676 - accuracy: 0.8368 - val_loss: 1.1620 - val_acc
uracy: 0.8393
Epoch 4/10
125/125 [==============================] - 101s 812ms/step -
loss: 1.1151 - accuracy: 0.8388 - val_loss: 1.1435 - val_acc
uracy: 0.8403
Epoch 5/10
125/125 [==============================] - 102s 815ms/step -
loss: 1.0725 - accuracy: 0.8408 - val_loss: 1.1274 - val_acc
uracy: 0.8408
Epoch 6/10
125/125 [==============================] - 102s 816ms/step -
loss: 1.0336 - accuracy: 0.8426 - val_loss: 1.1094 - val_acc
uracy: 0.8424
Epoch 7/10
125/125 [==============================] - 102s 816ms/step -
loss: 0.9965 - accuracy: 0.8443 - val_loss: 1.1059 - val_acc
uracy: 0.8426
Epoch 8/10
125/125 [==============================] - 102s 814ms/step -
loss: 0.9616 - accuracy: 0.8463 - val_loss: 1.0985 - val_acc
uracy: 0.8422
Epoch 9/10
125/125 [==============================] - 102s 814ms/step -
loss: 0.9272 - accuracy: 0.8480 - val_loss: 1.0939 - val_acc
uracy: 0.8435
Epoch 10/10
125/125 [==============================] - 102s 813ms/step -
loss: 0.8934 - accuracy: 0.8499 - val_loss: 1.0952 - val_acc
uracy: 0.8431
```

Out[ ]:

```
<keras.callbacks.History at 0x7efd182b96d0>
```

In [ ]:

```
# Save model
model.save("s2s")
```

```
WARNING:absl:Found untraced functions such as lstm_cell_laye
r_call_fn, lstm_cell_layer_call_and_return_conditional_losse
s, lstm_cell_1_layer_call_fn, lstm_cell_1_layer_call_and_ret
urn_conditional_losses, lstm_cell_2_layer_call_fn while savi
ng (showing 5 of 8). These functions will not be directly ca
llable after loading.
WARNING:absl:<keras.layers.recurrent.LSTMCell object at 0x7e
fd182f28d0> has the same name 'LSTMCell' as a built-in Keras
object. Consider renaming <class 'keras.layers.recurrent.LST
MCell'> to avoid naming conflicts when loading with `tf.kera
s.models.load_model`. If renaming is not possible, pass the
object in the `custom_objects` parameter of the load functio
n.
WARNING:absl:<keras.layers.recurrent.LSTMCell object at 0x7e
fd182ea710> has the same name 'LSTMCell' as a built-in Keras
object. Consider renaming <class 'keras.layers.recurrent.LST
MCell'> to avoid naming conflicts when loading with `tf.kera
s.models.load_model`. If renaming is not possible, pass the
object in the `custom_objects` parameter of the load functio
n.
WARNING:absl:<keras.layers.recurrent.LSTMCell object at 0x7e
fd1829ef10> has the same name 'LSTMCell' as a built-in Keras
object. Consider renaming <class 'keras.layers.recurrent.LST
MCell'> to avoid naming conflicts when loading with `tf.kera
s.models.load_model`. If renaming is not possible, pass the
object in the `custom_objects` parameter of the load functio
n.
WARNING:absl:<keras.layers.recurrent.LSTMCell object at 0x7e
fd1823a510> has the same name 'LSTMCell' as a built-in Keras
object. Consider renaming <class 'keras.layers.recurrent.LST
MCell'> to avoid naming conflicts when loading with `tf.kera
s.models.load_model`. If renaming is not possible, pass the
object in the `custom_objects` parameter of the load functio
n.
```

In [ ]:

```
# encoder inference
latent_dim = 500
# load the model
model = models.load_model("s2s")
```

In [ ]:

```
# construct encoder model from the output of 6 layer i.e.last LSTM layer
en_outputs, state_h_enc, state_c_enc = model.layers[6].output
en_states = [state_h_enc, state_c_enc]
# add input and state from the layer.
en_model = Model(model.input[0], [en_outputs]+en_states)
```

In [ ]:

```
# decoder inference
# create Input object for hidden and cell state for decoder
# shape of layer with hidden or latent dimension
dec_state_input_h = Input(shape=(latent_dim,))
dec_state_input_c = Input(shape=(latent_dim,))
dec_hidden_state_input = Input(shape=(max_in_len, latent_dim))
```

In [ ]:

```
# Get the embeddings and input layer from the model
dec_inputs = model.input[1]
dec_emb_layer = model.layers[5]
dec_lstm = model.layers[7]
dec_embedding = dec_emb_layer(dec_inputs)
```

In [ ]:

```
# add input and initialize LSTM layer with encoder LSTM states.
dec_outputs2, state_h2, state_c2 = dec_lstm(
    dec_embedding, initial_state=[dec_state_input_h, dec_state_input_c])
```

In [ ]:

```
# Attention layer
attention = model.layers[8]
attn_out2 = attention([dec_outputs2, dec_hidden_state_input])

merge2 = Concatenate(axis=-1)([dec_outputs2, attn_out2])
```

In [ ]:

```
# Finally define the Model Class
dec_model = Model(
    [dec_inputs] + [dec_hidden_state_input, dec_state_input_h, dec_state
_input_c],
    [dec_outputs2] + [state_h2, state_c2])
```

In [ ]:

```
# create a dictionary with a key as index and value as words.
reverse_target_word_index = tr_tokenizer.index_word
reverse_source_word_index = in_tokenizer.index_word
target_word_index = tr_tokenizer.word_index
reverse_target_word_index[0] = ' '
```

In [ ]:

```
def decode_sequence(input_seq):
    # get the encoder output and states by passing the input sequence
    en_out, en_h, en_c = en_model.predict(input_seq)

    # target sequence with inital word as 'sos'
    target_seq = np.zeros((1, 1))
    target_seq[0, 0] = target_word_index['sos']

    # if the iteration reaches the end of text than it will be stop the iteration
    stop_condition = False
    # append every predicted word in decoded sentence
    decoded_sentence = ""
    while not stop_condition:
        # get predicted output, hidden and cell state.
        output_words, dec_h, dec_c = dec_model.predict(
            [target_seq] + [en_out, en_h, en_c])

        # get the index and from the dictionary get the word for that index.
        word_index = np.argmax(output_words[0, -1, :])
        text_word = reverse_target_word_index[word_index]
        decoded_sentence += text_word + " "

        # Exit condition: either hit max length
        # or find a stop word or last word.
        if text_word == "eos" or len(decoded_sentence) > max_tr_len:
            stop_condition = True

        # update target sequence to the current word index.
        target_seq = np.zeros((1, 1))
        target_seq[0, 0] = word_index
        en_h, en_c = dec_h, dec_c

    # return the deocded sentence
    return decoded_sentence
```

In [ ]:

```python
inp_review = input("Enter : ")
print("Review :", inp_review)

inp_review = clean(inp_review, "inputs")
inp_review = ' '.join(inp_review)
inp_x = in_tokenizer.texts_to_sequences([inp_review])
inp_x = pad_sequences(inp_x,  maxlen=max_in_len, padding='post')

summary = decode_sequence(inp_x.reshape(1, max_in_len))
if 'eos' in summary:
    summary = summary.replace('eos', '')
print("\nPredicted summary:", summary)
print("\n")
```

```
Review: I went to hotel Astor yesterday, I ordered chicken b
iriyani,it was tasty specially the leg piece was very spicy
and the behavior of the waiter was very good. I would recomm
end everyone to go there

Predicted summary: The chicken biriyani of hotel Astor is ta
sty and recommendable
```