Import the important modules

In [24]:

```
import pandas as pd # for Dataframe.
import numpy as np # for array formation.
import pickle
import datetime # for datetime.
import string
import random as ran # for randomization
from random import randint
import matplotlib.pyplot as plt # for plotting
import matplotlib.image as mpimg
import re # for regular expression
import nltk # for natural language processing
import tensorflow as tf # for tensorflow
import warnings
warnings.filterwarnings('ignore')
from tqdm import tqdm
from nltk.translate.bleu_score import sentence_bleu
from sklearn.utils import shuffle #for randomization in data.
from sklearn.model_selection import train_test_split #split the data
from tensorflow.keras.applications.xception import Xception ,preprocess_input # use pre-trained xc
eption model for image feature extraction.
from tensorflow.keras.preprocessing import image
from tensorflow.keras.models import Model
from tensorflow.keras.layers import Dense, Dropout, Input, Conv2D
from tensorflow.keras.applications import densenet
from tensorflow.keras.preprocessing.text import Tokenizer# for tokenization of text data.
from tensorflow.keras.preprocessing.sequence import pad_sequences # padding the text tokenize sequ
ence.
```

Let's import the data files

In [25]:

```
path_of_image='/content/drive/My Drive/NLMCXR_png/'   # from this path we get our images.
test_input = np.load("/content/test_input.npy",allow_pickle=True)
test_output = np.load("/content/test_output.npy",allow_pickle=True)
```

MAKE THE WORD EMBEDDINGS USING FATSTEXT PRE-TRAINED MODELS

tokenizer

In [4]:

```
token = pickle.load(open("/content/tokenizer.pkl", 'rb'))
embedding_matrix = pickle.load(open("/content/embedding_matrix_oversample.pkl", 'rb'))
path= pickle.load(open("/content/path.pkl", 'rb'))
```

In [5]:

```
from google.colab import drive# import the drive
drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

In [6]:

```
maximum_length_output_sentences= 80
```

In [7]:

```
SIZE_OF_BATCH=32 #Batch size
SIZE_OF_BUFFER= 500  #Batch Buffer
DIMENSION_OF_EMBEDDING= 300 #Embedding
```

```
UNITS= 300  #units
```

Lets get encoder and decoder

In [8]:

```
from tensorflow.keras.layers import Dense, Flatten, Dropout, Conv2D, Reshape, Concatenate
class encoder(tf.keras.Model):
  """ encoder for image features extracted by pre-trained model"""
  def __init__(self,DIMENSION_OF_EMBEDDING):
    super(encoder,self).__init__()
    self.flat=tf.keras.layers.Flatten()
    self.dense = tf.keras.layers.Dense(DIMENSION_OF_EMBEDDING, kernel_initializer=tf.keras.initiali
zers.glorot_uniform(seed=45),name='output_layer_of_encoder')# dense layer.

  def call(self, a):
    concatination_enc= Concatenate()([a[:,0], a[:,1]])# concatenate
    a=self.flat(concatination_enc)
    a =self.dense(a)
    return a
```

In [9]:

```
class decoder(tf.keras.Model):
  """ RNN decoder with attention over image features."""
  def __init__(self,  DIMENSION_OF_EMBEDDING, UNITS, size_of_vocabulary):
        super(decoder, self).__init__()
        self.units = UNITS
        self.concat = tf.keras.layers.Concatenate()
        self.embedding = tf.keras.layers.Embedding(size_of_vocabulary,DIMENSION_OF_EMBEDDING,weight
s=[embedding_matrix], input_length=maximum_length_output_sentences, trainable=False)
        self.lstm = tf.keras.layers.LSTM(self.units,
                                         return_sequences=True,
                                         return_state=True,
                                         recurrent_initializer=tf.keras.initializers.glorot_uniform(s
ed=45))
        self.dense = tf.keras.layers.Dense(size_of_vocabulary, kernel_initializer=tf.keras.initiali
zers.glorot_uniform(seed=45))
        self.attention = tf.keras.layers.AdditiveAttention(self.units)
        self.flatten = tf.keras.layers.Flatten()
  def call(self, a,features,hidden):
        attention_outputs = self.attention([features,hidden]) # attention have the encoder
features and the hidden states
        embedding = self.embedding(a)# here we make the embedding of text
        concat_output = self.concat([embedding,tf.expand_dims(attention_outputs,1)])# here we conca
t the embedding and attention output
        output, prev_state_vector,_ = self.lstm(concat_output)# here we pass the concat output
        a= self.flatten(output)
        a= self.dense(a)
        return a,prev_state_vector
```

Extract the image features with the help of chexnet pre-trained model

In [10]:

```
size_of_vocabulary=1445
Encoder= encoder(DIMENSION_OF_EMBEDDING) # encoder
Decoder= decoder(DIMENSION_OF_EMBEDDING, UNITS, size_of_vocabulary)# decoder
Encoder.built = True
Decoder.built = True
encod_temp = Encoder(np.random.rand(1,30,1024))
decod_temp = Decoder(np.random.rand(1,1),np.random.rand(1,300),np.random.rand(1,300))
Encoder.load_weights('/content/abhi_krishna_oversample_weights_encoder_final_final.h5')
Decoder.load_weights('/content/drive/MyDrive/abhi_krishna_oversample_weights_decoder_final.h5')
```

In [19]:

```
chex = densenet.DenseNet121(include_top=False, weights = None, input_shape=(299,299,3))
X = chex.output
X = Dense(14, activation="sigmoid", name="predictions")(X)
model = Model(inputs=chex.input, outputs=X)
```

```
model.load_weights('/content/drive/MyDrive/brucechou1983_CheXNet_Keras_0.3.0_weights.h5')
model = Model(inputs = model.input, outputs = model.layers[-2].output)
avg_pooling=tf.keras.layers.GlobalAveragePooling2D(data_format=None)(model.output)
model_for_image_features=Model(inputs=model.input,outputs=avg_pooling)
```

In [20]:

```
def tensor_of_image(path_of_image, name_of_image, model):
  """ Here we extract the features of the image"""
  i = tf.io.read_file(path_of_image + str(name_of_image)) # read file
  i = tf.image.decode_jpeg(i, channels=3) # decode the jpeg
  i = tf.image.resize(i, (299,299)) # resize the image
  i = tf.keras.applications.xception.preprocess_input(i) # extract the features with the help of xc
eption model.
  features_of_the_image = model(tf.constant(i)[None, :]) # features of image.
  return features_of_the_image
```

In [37]:

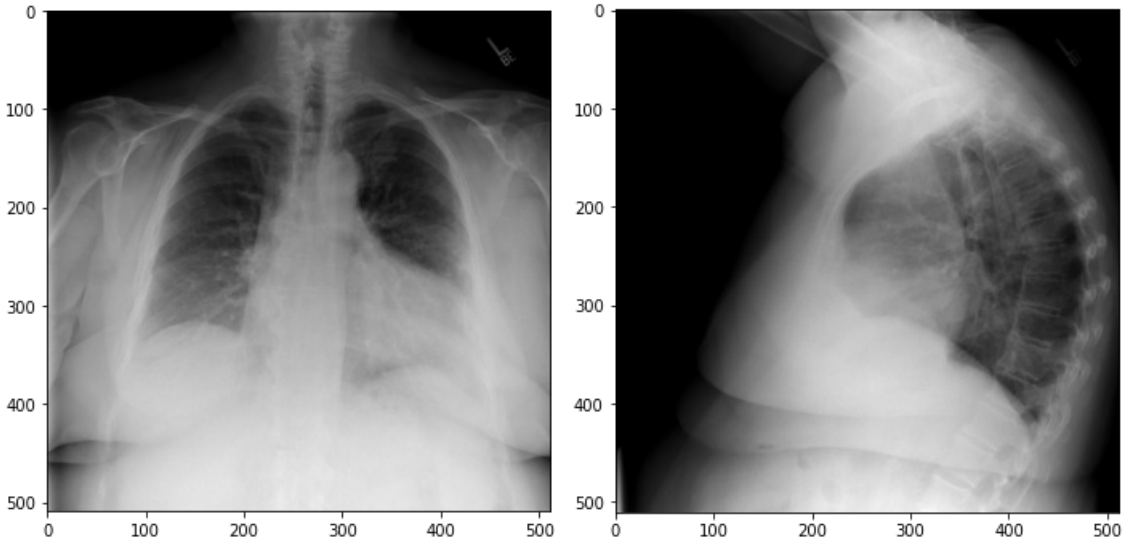
```
def score(x):
    """cumulative score of the sentences"""
    return x[1]/len(x[0])

def FINAL_FUNCTION_1(name_of_image, beam_index=3):
    """take image as input in beam search"""
    figure, axis = plt.subplots(1,len(name_of_image), figsize= (10,10), tight_layout=True)
    count=0
    for image, subplot in zip(name_of_image, axis.flatten()):
      image_= mpimg.imread(path_of_image+image)
      imageplot = axis[count].imshow(image_, cmap ='bone')
      count +=1
    plt.show()
    hidden_1 =  tf.zeros((1, UNITS))# Initialize the hidden state
    tensor_of_im = tf.convert_to_tensor([tensor_of_image(path_of_image,path[0],
model_for_image_features),# img[0],img[1]
                                         tensor_of_image(path_of_image,path[1],
model_for_image_features)])
    features_of_image = tf.constant(tensor_of_im)[None, :]# get the features of the image
    values_of_features = Encoder(features_of_image)# get the encoder output
    start = [token.word_index["<start>"]] # here we get the start index
    word_decoder = [[start, 0.0]]
    while len(word_decoder[0][0]) < maximum_length_output_sentences:
        temp = []
        for s in word_decoder:
            predict,hidden_1 = Decoder(tf.cast(tf.expand_dims([s[0][-1]], 0), tf.float32),
values_of_features, hidden_1) # het the output from the decoder
            word_preds = np.argsort(predict[0])[-beam_index:]# here we return the indices of the pr
edictions
            # Getting the top <beam_index>(n) predictions and creating a
            # new list so as to put them via the model again
            for w in word_preds:
                next_cap, prob = s[0][:], s[1]# here we get the next impresssiona and probability s
core
                next_cap.append(w)
                prob += predict[0][w]
                temp.append([next_cap, prob.numpy()])
        word_decoder = temp
        # Sorting according to the probabilities scores
        word_decoder = sorted(word_decoder, reverse=False, key=score)
        # Getting the top words
        word_decoder = word_decoder[-beam_index:]
    word_decoder = word_decoder[-1][0]
    impression = [token.index_word[i] for i in word_decoder if i !=0]
    result = []

    for i in impression:
        if i != '<end>':
            result.append(i)
        else:
            break
    text = ' '.join(result[1:])
    return result, text
```

In [39]:

```
def FINAL_FUNCTION_2(result,text,actual_text):
    reference = [actual_text.split()[1:-1]]
    result = result[:-1]
    print('='*50)
    print("Actual impression is:", actual_text)
    print("Predicted impression is :",text)
    print('*'*50)
    print('One-gram: {:.4f}  || Cumulative  one gram: {:.4f}'.format(sentence_bleu(reference, resul
t, weights=(1, 0, 0, 0)), sentence_bleu(reference, result, weights=(1, 0, 0, 0))))
    print('Two-gram: {:.4f}  || Cumulative  two gram: {:.4f}'.format(sentence_bleu(reference, resul
t, weights=(0, 1, 0, 0)), sentence_bleu(reference, result, weights=(0.5, 0.5, 0, 0))))
    print('Three-gram: {:.4f}|| Cumulative  three gram: {:.4f}'.format(sentence_bleu(reference, res
ult, weights=(0, 0, 1, 0)), sentence_bleu(reference, result, weights=(0.33, 0.33, 0.33, 0))))
    print('Four-gram: {:.4f} || Cumulative four gram: {:.4f}'.format(sentence_bleu(reference, resul
t, weights=(0, 0, 0, 1)), sentence_bleu(reference, result, weights=(0.25, 0.25, 0.25, 0.25))))
```

In [40]:

```
result,predicted_text= FINAL_FUNCTION_1(test_input[1])
actual = test_output[1]
FINAL_FUNCTION_2(result,predicted_text,actual)
```




```
==================================================
Actual impression is: <start> stable cardiomegaly clear lungs <end>
Predicted impression is : with clear infiltrate disease chest within
**************************************************
One-gram: 0.1667  || Cumulative  one gram: 0.1667
Two-gram: 1.0000  || Cumulative  two gram: 0.4082
Three-gram: 1.0000|| Cumulative  three gram: 0.5536
Four-gram: 1.0000 || Cumulative four gram: 0.6389
```