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

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

```
from google.colab import drive
drive.mount('/content/drive')
!unzip drive/MyDrive/aclImdb.zip
```

```
Streaming output truncated to the last 5000 lines.
  inflating: aclImdb/train/pos/9260_7.txt
  inflating: __MACOSX/aclImdb/train/pos/._9260_7.txt
  inflating: aclImdb/train/pos/1599_7.txt
  inflating: __MACOSX/aclImdb/train/pos/._1599_7.txt
  inflating: aclImdb/train/pos/2174_8.txt
  inflating: __MACOSX/aclImdb/train/pos/._2174_8.txt
  inflating: aclImdb/train/pos/2309_9.txt
  inflating: __MACOSX/aclImdb/train/pos/._2309_9.txt
  inflating: aclImdb/train/pos/12034_10.txt
  inflating: __MACOSX/aclImdb/train/pos/._12034_10.txt
  inflating: aclImdb/train/pos/11703_9.txt
  inflating: __MACOSX/aclImdb/train/pos/._11703_9.txt
  inflating: aclImdb/train/pos/5619_9.txt
  inflating: __MACOSX/aclImdb/train/pos/._5619_9.txt
  inflating: aclImdb/train/pos/2928_10.txt
  inflating: __MACOSX/aclImdb/train/pos/._2928_10.txt
  inflating: aclImdb/train/pos/7096_10.txt
  inflating: __MACOSX/aclImdb/train/pos/._7096_10.txt
  inflating: aclImdb/train/pos/793_9.txt
  inflating: __MACOSX/aclImdb/train/pos/._793_9.txt
  inflating: aclImdb/train/pos/7693_9.txt
  inflating: __MACOSX/aclImdb/train/pos/._7693_9.txt
  inflating: aclImdb/train/pos/8293_8.txt
  inflating: __MACOSX/aclImdb/train/pos/._8293_8.txt
  inflating: aclImdb/train/pos/29_10.txt
  inflating: __MACOSX/aclImdb/train/pos/._29_10.txt
  inflating: aclImdb/train/pos/8642_8.txt
  inflating: __MACOSX/aclImdb/train/pos/._8642_8.txt
  inflating: aclImdb/train/pos/3187_7.txt
  inflating: __MACOSX/aclImdb/train/pos/._3187_7.txt
  inflating: aclImdb/train/pos/4497_7.txt
  inflating: __MACOSX/aclImdb/train/pos/._4497_7.txt
  inflating: aclImdb/train/pos/2659_8.txt
  inflating: __MACOSX/aclImdb/train/pos/._2659_8.txt
  inflating: aclImdb/train/pos/10119_7.txt
  inflating: __MACOSX/aclImdb/train/pos/._10119_7.txt
  inflating: aclImdb/train/pos/1665_7.txt
```

```
inflating: __MACOSX/aclImdb/train/pos/._1665_7.txt
inflating: aclImdb/train/pos/11078_10.txt
inflating: __MACOSX/aclImdb/train/pos/._11078_10.txt
inflating: aclImdb/train/pos/4840_7.txt
inflating: __MACOSX/aclImdb/train/pos/._4840_7.txt
inflating: aclImdb/train/pos/11729_10.txt
inflating: __MACOSX/aclImdb/train/pos/._11729_10.txt
inflating: aclImdb/train/pos/7570_10.txt
inflating: __MACOSX/aclImdb/train/pos/._7570_10.txt
inflating: aclImdb/train/pos/6047_10.txt
inflating: __MACOSX/aclImdb/train/pos/._6047_10.txt
inflating: aclImdb/train/pos/9292_10.txt
inflating: __MACOSX/aclImdb/train/pos/._9292_10.txt
inflating: aclImdb/train/pos/5798_8.txt
inflating: __MACOSX/aclImdb/train/pos/._5798_8.txt
inflating: aclImdb/train/pos/639_10.txt
inflating: __MACOSX/aclImdb/train/pos/._639_10.txt
inflating: aclImdb/train/pos/8508_7.txt
inflating: __MACOSX/aclImdb/train/pos/._8508_7.txt
inflating: aclImdb/train/pos/10216_8.txt
inflating: __MACOSX/aclImdb/train/pos/._10216_8.txt
inflating: aclImdb/train/pos/9125_10.txt
```

```
#Standard Python Library

import pandas as pd
import numpy as np
import seaborn as sns
import json
import os

#Standar NLP Pre-Processing Library

import nltk as nlp
from nltk.corpus import stopwords
import string
import re
import matplotlib.pyplot as plt
from sklearn.feature_extraction.text import CountVectorizer, TfidfVectorizer
from sklearn import feature_extraction, linear_model, model_selection, preprocessir
from sklearn.multiclass import OneVsRestClassifier
from sklearn.metrics import accuracy_score
from sklearn.model_selection import train_test_split
from sklearn.feature_extraction.text import TfidfTransformer
from sklearn.pipeline import Pipeline
from sklearn.svm import LinearSVC
from sklearn.linear_model import LogisticRegression
from sklearn.naive_bayes import GaussianNB,BernoulliNB,MultinomialNB,MultinomialNB
```

```
#SK Learn and TF library for NLP NueralNet Layers
from sklearn.ensemble import GradientBoostingClassifier
from sklearn.tree import DecisionTreeClassifier
from sklearn.neighbors import KNeighborsClassifier
from sklearn.linear_model import SGDClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.preprocessing import LabelEncoder, MultiLabelBinarizer
from sklearn.gaussian_process import GaussianProcessClassifier
from tensorflow.keras.models import Model, Sequential
from tensorflow.keras.layers import LSTM, Activation, Dense, Dropout, Input, Embedd
from tensorflow.keras.preprocessing.text import Tokenizer
from tensorflow.keras.preprocessing import sequence
from tensorflow.keras.callbacks import EarlyStopping
from tensorflow.keras.utils import to_categorical

from sklearn.metrics import accuracy_score, confusion_matrix, classification_report

from tensorflow.keras.utils import plot_model

#Logistic Regression Library
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import train_test_split
from sklearn.neural_network import MLPClassifier

#Naive Bayes Library
from sklearn.naive_bayes import GaussianNB

#KNN Libraries
from sklearn.preprocessing import StandardScaler
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import classification_report, confusion_matrix


#LSTM Libraries
from keras.layers import BatchNormalization, LSTM, GRU
from keras.preprocessing.sequence import pad_sequences
import keras.backend as backend
from nltk import word_tokenize, KneserNeyProbDist, SimpleGoodTuringProbDist, FreqDi
```

Setting up Juypter Notebook template for Project

```
"""
READS Text File and return all of body as a string
"""
def read_input(input_path:str) -> str:
    file_data = open(input_path , 'r')

    return file_data.read()

def read_directory(input_dir:str):
  data = []
  #print(input_dir)
  files = [f for f in os.listdir(input_dir)]
  #print(files)
  for f in files:
    #print("entered")
    with open (input_dir+"/"+f, "r") as myfile:
     # print(myfile.read())
      data.append(myfile.read())

  df = pd.DataFrame(data)
  return df

train_pos = read_directory('/content/aclImdb/train/pos')
train_neg = read_directory('/content/aclImdb/train/neg')
test_pos = read_directory('/content/aclImdb/test/pos')
test_neg = read_directory('/content/aclImdb/test/neg')
```

```
def preprocess(doc, label, sample_size):
    data_list=[]
    for paragraphs in doc.values:
      #print(paragraphs[0])
      da = paragraphs[0].split('\n\n')
      data_set = [paragraph.strip() for paragraph in da if len(paragraph) > sample_
      data = [re.sub('[\W_]+', ' ', sample.lower().strip()) for sample in data_set]
      if len(data)>0:
        data_list.append(data[0])
    size = len(data_list)

    label_array = np.ones((size,)) * label
    df = pd.DataFrame({'paragraph': data_list, 'category':label_array })
    print('The total number of examples for category ' + str(label)+ ' is: ' + str(
    return df, size

df1_train_pos,size=preprocess(train_pos,0,100)
df2_train_neg,size2=preprocess(train_neg,1,100)
df3_test_pos,size3=preprocess(test_pos,0,100)
df4_test_neg,size4=preprocess(test_neg,1,100)
```

```
The total number of examples for category 0 is: 12498
The total number of examples for category 1 is: 12493
The total number of examples for category 0 is: 12494
The total number of examples for category 1 is: 12495
```

```
df = pd.concat([df1_train_pos,df2_train_neg,df3_test_pos,df4_test_neg])

train = df['paragraph']
test = df['category']
df
```

	paragraph	category
0	far richer in texture and character than even ...	0.0
1	hitler the rise of evil is clearly produced b...	0.0
2	it s been so long since i ve seen this movie a...	0.0
3	caught the tail end of this movie channel surf...	0.0
4	it takes a little while to get used to nick no...	0.0
...	...	...
12490	i m just filling this comment out because i co...	1.0
12491	i can t say i was surprised at this atrocity w...	1.0
12492	maybe it s unfair to dislike a movie for what ...	1.0
12493	there are shows and films i ve seen and subseq...	1.0
12494	as someone has already mentioned on this board...	1.0

49980 rows × 2 columns

```
paragraphs = train.values
categorys = test

sentences_train, sentences_test, y_train, y_test = train_test_split(paragraphs, cat
X_train, X_val, y_train, y_val = train_test_split(sentences_train, y_train, test_si

tokenizer = Tokenizer(num_words=3000)
tokenizer.fit_on_texts(X_train)

X_train = tokenizer.texts_to_sequences(X_train)
X_validation = tokenizer.texts_to_sequences(X_val)
X_test = tokenizer.texts_to_sequences(sentences_test)

vocab_size = len(tokenizer.word_index) + 1

maxlen = 150

X_train = pad_sequences(X_train, padding='post', maxlen=maxlen)
X_validation = pad_sequences(X_validation, padding='post', maxlen=maxlen)
X_test = pad_sequences(X_test, padding='post', maxlen=maxlen)

label_train = to_categorical(y_train)
label_validation = to_categorical(y_val)
label_test = to_categorical(y_test)


print('Shape of x_train: ' + str(X_train.shape))
print('Shape of label_train: ' + str(label_train.shape))
print('Shape of x_validation: ' + str(X_validation.shape))
print('Shape of y_validation: ' + str(label_validation.shape))
print('Shape of x_test: ' + str(X_test.shape))
print('Shape of y_test: ' + str(label_test.shape))

    Shape of x_train: (18992, 100)
    Shape of label_train: (18992, 2)
    Shape of x_validation: (1000, 100)
    Shape of y_validation: (1000, 2)
    Shape of x_test: (4999, 100)
    Shape of y_test: (4999, 2)


# neural network
inputs = Input(shape=(maxlen,))
embedding = Embedding(vocab_size, 100)(inputs)
```

```
import tensorflow as tf
# layer 1
conv1 = tf.keras.layers.Conv1D(filters=10, kernel_size=3, activation='relu')(embedd
drop1 = Dropout(0.5)(conv1)
pool1 = tf.keras.layers.MaxPooling1D(pool_size=3)(drop1)
flat1 = tf.keras.layers.Flatten()(pool1)

# layer 2
conv2 = tf.keras.layers.Conv1D(filters=10, kernel_size=2, activation='sigmoid')(emb
drop2 = Dropout(0.5)(conv2)
pool2 = tf.keras.layers.MaxPooling1D(pool_size=3)(drop2)
flat2 = tf.keras.layers.Flatten()(pool2)

# layer 3
conv3 = tf.keras.layers.Conv1D(filters=10, kernel_size=3, activation='softmax')(emb
drop3 = Dropout(0.5)(conv3)
pool3 = tf.keras.layers.MaxPooling1D(pool_size=3)(drop3)
flat3 = tf.keras.layers.Flatten()(pool3)

# layer 4
# conv4 = tf.keras.layers.Conv1D(filters=10, kernel_size=3, activation='relu')(embe
# drop4 = Dropout(0.5)(conv4)
# pool4 = tf.keras.layers.MaxPooling1D(pool_size=3)(drop4)
# flat4 = tf.keras.layers.Flatten()(pool4)

# layer 5
# conv5 = tf.keras.layers.Conv1D(filters=12, kernel_size=3, activation='tanh')(embe
# drop5 = Dropout(0.6)(conv5)
# pool5 = tf.keras.layers.MaxPooling1D(pool_size=3)(drop5)
# flat5 = tf.keras.layers.Flatten()(pool5)


# merge
network = tf.keras.layers.concatenate([flat1, flat2, flat3])

# interpretation
dense1 = Dense(10, activation='relu')(network)
outputs = Dense(2, activation='softmax')(dense1)
cnn_model = Model(inputs=[inputs], outputs=outputs)
# compile
opt = tf.keras.optimizers.Adam(learning_rate=0.01)
cnn_model.compile(loss='categorical_crossentropy', optimizer=opt, metrics=['accurac
# summarize
print(cnn_model.summary())
```

```
Model: "model_16"
__________________________________________________________________________________________________
 Layer (type)                   Output Shape         Param #     Connected to
==================================================================================================
 input_26 (InputLayer)          [(None, 150)]        0           []

 embedding_25 (Embedding)       (None, 150, 100)     9079100     ['input_26[0]

 conv1d_84 (Conv1D)             (None, 148, 10)      3010        ['embedding_2

 conv1d_85 (Conv1D)             (None, 149, 10)      2010        ['embedding_2

 conv1d_86 (Conv1D)             (None, 148, 10)      3010        ['embedding_2

 dropout_84 (Dropout)           (None, 148, 10)      0           ['conv1d_84[0

 dropout_85 (Dropout)           (None, 149, 10)      0           ['conv1d_85[0

 dropout_86 (Dropout)           (None, 148, 10)      0           ['conv1d_86[0

 max_pooling1d_83 (MaxPooling1D  (None, 49, 10)      0           ['dropout_84
 )

 max_pooling1d_84 (MaxPooling1D  (None, 49, 10)      0           ['dropout_85
 )

 max_pooling1d_85 (MaxPooling1D  (None, 49, 10)      0           ['dropout_86
 )

 flatten_81 (Flatten)           (None, 490)          0           ['max_pooling

 flatten_82 (Flatten)           (None, 490)          0           ['max_pooling

 flatten_83 (Flatten)           (None, 490)          0           ['max_pooling

 concatenate_16 (Concatenate)   (None, 1470)         0           ['flatten_81
                                                                  'flatten_82
                                                                  'flatten_83

 dense_32 (Dense)               (None, 10)           14710       ['concatenate

 dense_33 (Dense)               (None, 2)            22          ['dense_32[0]

==================================================================================================
Total params: 9,101,862
Trainable params: 9,101,862
Non-trainable params: 0
__________________________________________________________________________________________________
None
```

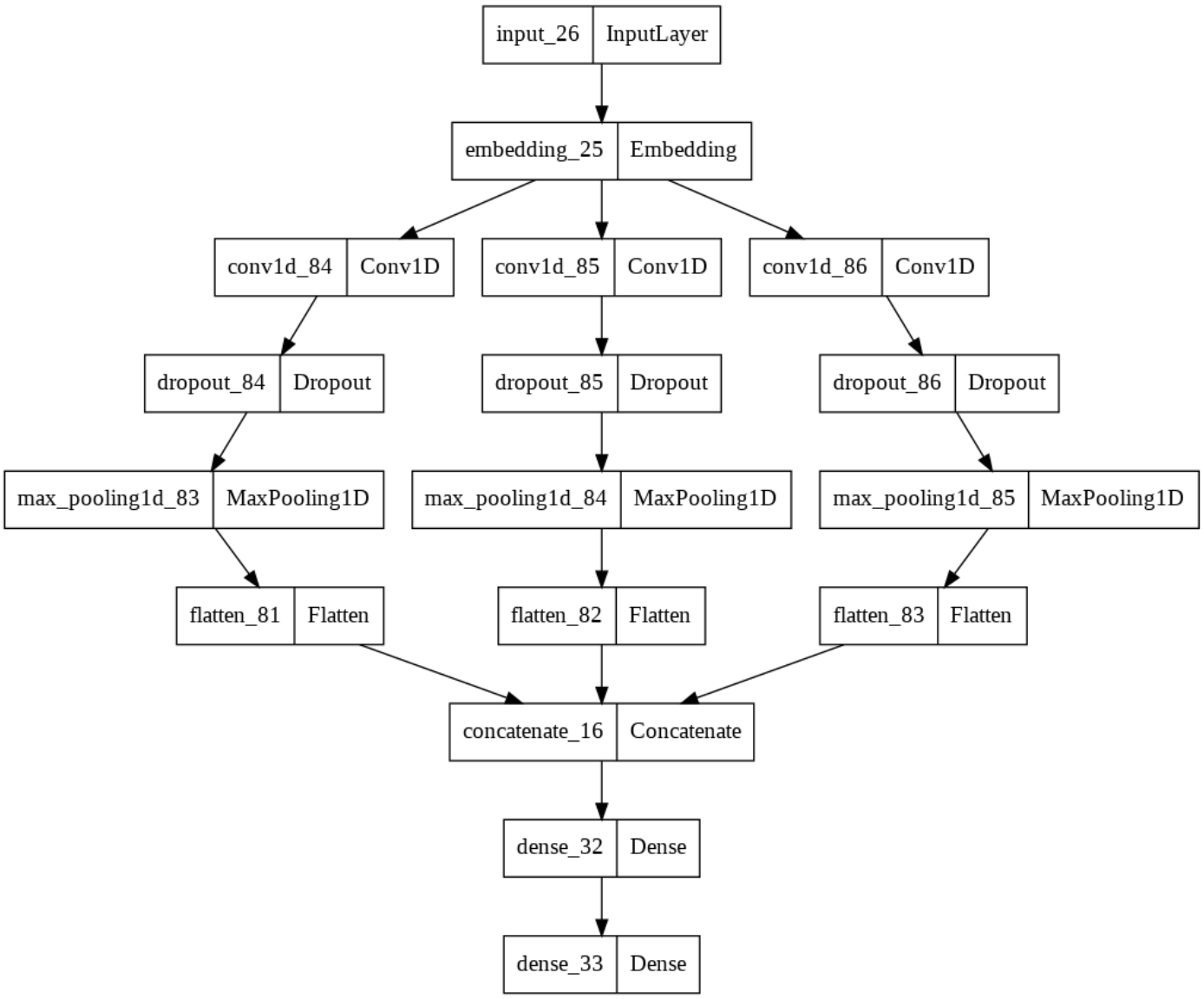
```
cnn_model.fit(X_train, label_train, batch_size=512, epochs=10, validation_data=(X_v
```

```
Epoch 1/10
75/75 [==============================] - 39s 504ms/step - loss: 0.6474 - accu
Epoch 2/10
75/75 [==============================] - 37s 499ms/step - loss: 0.3121 - accu
Epoch 3/10
75/75 [==============================] - 38s 501ms/step - loss: 0.2636 - accu
Epoch 4/10
75/75 [==============================] - 38s 504ms/step - loss: 0.2437 - accu
Epoch 5/10
75/75 [==============================] - 37s 499ms/step - loss: 0.2175 - accu
Epoch 6/10
75/75 [==============================] - 39s 519ms/step - loss: 0.1999 - accu
Epoch 7/10
75/75 [==============================] - 38s 512ms/step - loss: 0.1859 - accu
Epoch 8/10
75/75 [==============================] - 42s 558ms/step - loss: 0.1705 - accu
Epoch 9/10
75/75 [==============================] - 41s 550ms/step - loss: 0.1576 - accu
Epoch 10/10
75/75 [==============================] - 40s 532ms/step - loss: 0.1444 - accu
<keras.callbacks.History at 0x7f375a12a710>
```

```
def plot_training(H, N, plotPath):
    # construct a plot that plots and saves the training history
    plt.style.use("ggplot")
    plt.figure()
    plt.plot(np.arange(0, N), H.history["loss"], label="train_loss")
    plt.plot(np.arange(0, N), H.history["val_loss"], label="val_loss")
    plt.plot(np.arange(0, N), H.history["accuracy"], label="train_acc")
    plt.plot(np.arange(0, N), H.history["val_accuracy"], label="val_acc")
    plt.title("Training Loss and Accuracy")
    plt.xlabel("Epoch #")
    plt.ylabel("Loss/Accuracy")
    plt.legend(loc="lower left")
    plt.savefig(plotPath)
```

```
from tensorflow.keras.utils import plot_model

plot_model(cnn_model)
```


input_26 InputLayer
embedding_25 Embedding
conv1d_84 Conv1D
conv1d_85 Conv1D
conv1d_86 Conv1D
dropout_84 Dropout
dropout_85 Dropout
dropout_86 Dropout
max_pooling1d_83 MaxPooling1D
max_pooling1d_84 MaxPooling1D
max_pooling1d_85 MaxPooling1D
flatten_81 Flatten
flatten_82 Flatten
flatten_83 Flatten
concatenate_16 Concatenate
dense_32 Dense
dense_33 Dense

```
test_loss, test_acc = cnn_model.evaluate(X_test, label_test)
print(test_loss, test_acc)
```

```
313/313 [==============================] - 3s 10ms/step - loss: 0.3348 - accu
0.3347502648830414 0.8669467568397522
```