DEEP LEARNING ASSIGNMENT

Mini Project on Natural Language Processing

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CSE - 'P' Batch
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CS-6005 DEEP LEARNING ASSIGNMENT - 5

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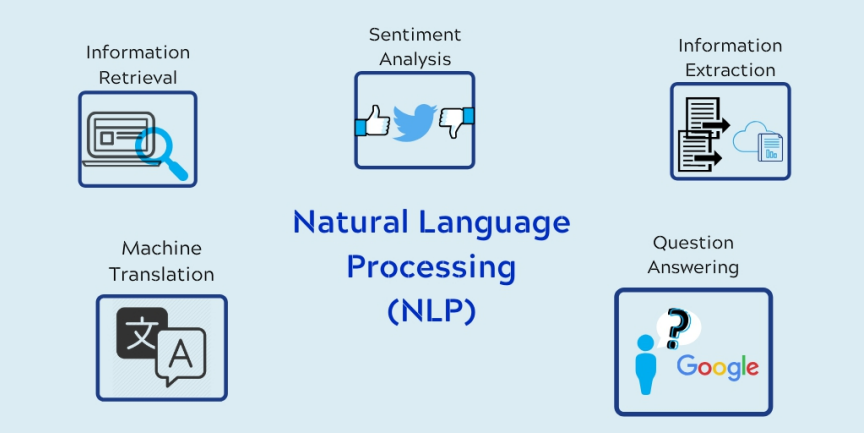
NATURAL LANGUAGE PROCESSING

1. INTRODUCTION:

In this project we try to do sentiment analysis on Covid-19 tweets using Natural Language Processing tools and Bi-Directional LSTM.

Natural language processing (NLP) refers to the branch of computer science and more specifically, the branch of artificial intelligence or AI concerned with giving computers the ability to understand text and spoken words in much the same way human beings can.

NLP combines computational linguistics rule-based modeling of human language with statistical, machine learning, and deep learning models. Together, these technologies enable computers to process human language in the form of text or voice data and to understand its full meaning, complete with the speaker or writer's intent and sentiment.

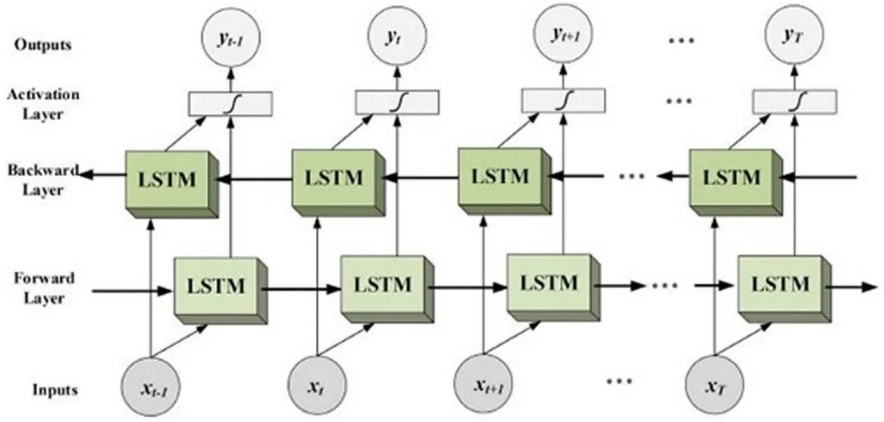


The Python programing language provides a wide range of tools and libraries for attacking specific NLP tasks. Many of these are found in the Natural Language Toolkit, or NLTK, an open source collection of libraries, programs, and education resources for building NLP programs.

2. BI-DIRECTIONAL LSTM :

Bidirectional LSTMs are an extension of traditional LSTMs that can improve model performance on sequence classification problems.

In problems where all timesteps of the input sequence are available, Bidirectional LSTMs train two instead of one LSTMs on the input sequence.This can provide additional context to the network and result in faster and even fuller learning on the problem.



The idea of Bidirectional Recurrent Neural Networks (RNNs) involves duplicating the first recurrent layer in the network so that there are now two layers side-by-side, then providing the input sequence as-is as input to the first layer and providing a reversed copy of the input sequence to the second.

This approach has been used to great effect with Long Short-Term Memory (LSTM) Recurrent Neural Networks. The use of providing the sequence bi-directionally was initially justified in the domain of speech recognition because there is evidence that the context of the whole utterance is used to interpret what is being said rather than a linear interpretation.

In Bi-LSTM you preserve information from the future and using the two hidden states combined you are able in any point of time to preserve information from both **past and future**.

3. DATASET :

The dataset is consists of tweets related to Covid-19. Data is extracted from twitter accounts of relevant most followed accounts using Twitter API. The accounts include, but are not limited to news sources, medical organizations, politicians and relevant ministers. Dataset consists of the following columns :

1) Location
2) Tweet At
3) Original Tweet
4) Label

In the upcoming modules we will perform some EDA on the dataset for pre-processing. Below is a small glimpse of the dataset.

UserName	ScreenNa...	Location	TweetAt	OriginalTw...	Sentiment
1	44953	NYC	02-03-2020	TRENDING: New Yorkers encounter empty supermarket shelves (pictured, Wegmans in Brooklyn), sold-out ...	Extremely Negative
2	44954	Seattle, WA	02-03-2020	When I couldn't find hand sanitizer at Fred Meyer, I turned to #Amazon. But $114.97 for a 2 pack of ...	Positive
3	44955		02-03-2020	Find out how you can protect yourself and loved ones from #coronavirus. ?	Extremely Positive

The target value is the ‘Sentiment’ column which has 5 classes namely Positive, Negative, Neutral, Extremely Positive, Extremely Negative.

4. MODULE LIST :

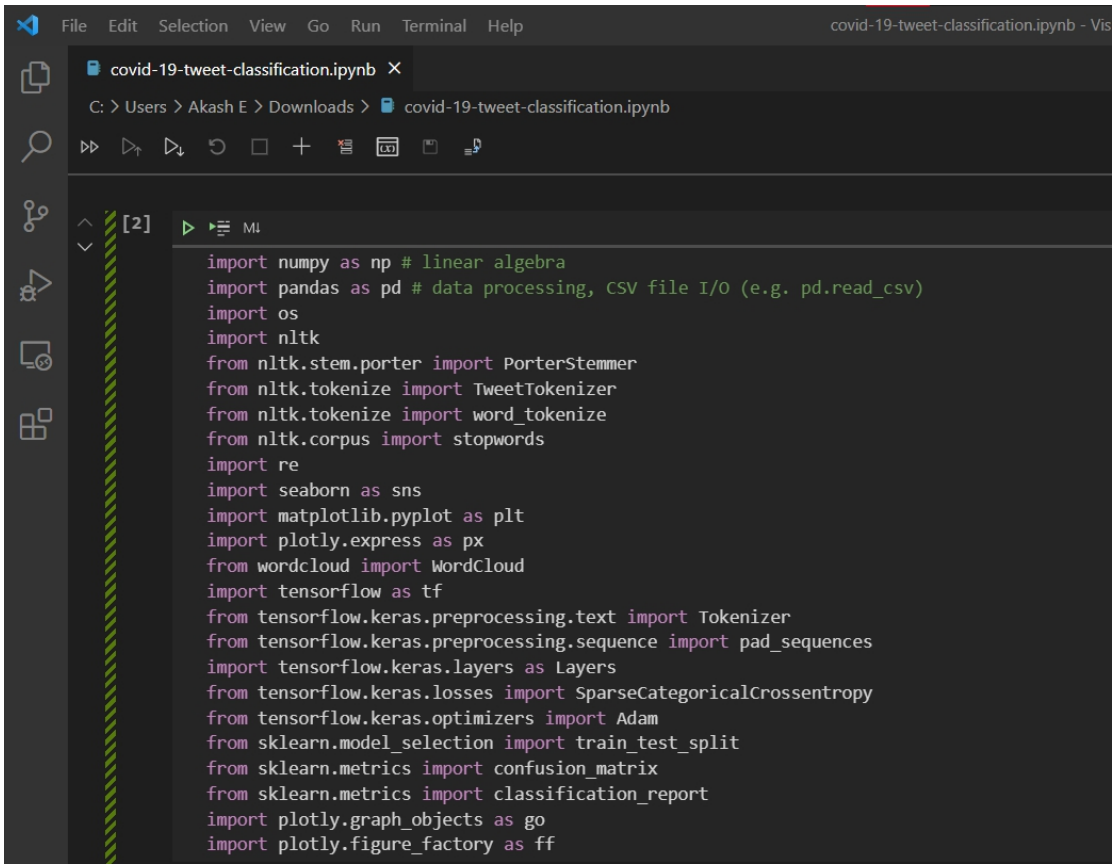
1. Exploratory Data Analysis.
2. Data Pre-Processing.
3. Word Embedding.
4. Model Building and Training.
5. Result Analysis.

5. MODULE ELABORATION:

5.1 Exploratory Data Analysis :

In this module we import the data to our project and do some data visualization and exploration.

First, we import all the necessary libraries :



Importing the dataset :

covid-19-tweet-classification.ipynb

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[3]
```
train=pd.read_csv("C:/Users/Akash E/Downloads/input/covid-19-nlp-text-classification/Corona_NLP_train.csv",encoding='latin1')
```

[4]
```
train.head()
```

	UserName	ScreenName	Location	TweetAt	OriginalTweet	Sentiment
0	3799	48751	London	16-03-2020	@MeNyrbie @Phil_Gahan @Chrisitv https://t.co/i...	Neutral
1	3800	48752	UK	16-03-2020	advice Talk to your neighbours family to excha...	Positive
2	3801	48753	Vagabonds	16-03-2020	Coronavirus Australia: Woolworths to give elde...	Positive
3	3802	48754	NaN	16-03-2020	My food stock is not the only one which is emp...	Positive
4	3803	48755	NaN	16-03-2020	Me, ready to go at supermarket during the #COV...	Extremely Negative

[5]
```
train['Location'].unique()
```

```
array(['London', 'UK', 'Vagabonds', ..., 'Juba south sudan', 'OHIO',
       'i love you so much || he/him'], dtype=object)
```

covid-19-tweet-classification.ipynb

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[6]
```
train['Location'].value_counts()
```

```
London                        540
United States                 528
London, England               520
New York, NY                  395
Washington, DC                373
                             ...
East Ferris                     1
Wirral UK                       1
??????                          1
USA, Europe, Brazil             1
California ? Washington DC      1
Name: Location, Length: 12220, dtype: int64
```

[7]
```
train.isnull().sum()
```

```
UserName          0
ScreenName        0
Location       8590
TweetAt           0
OriginalTweet     0
Sentiment         0
dtype: int64
```

[8]
```
train.shape
```

```
(41157, 6)
```

covid-19-tweet-classification.ipynb

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[9]

```
train.describe()
```

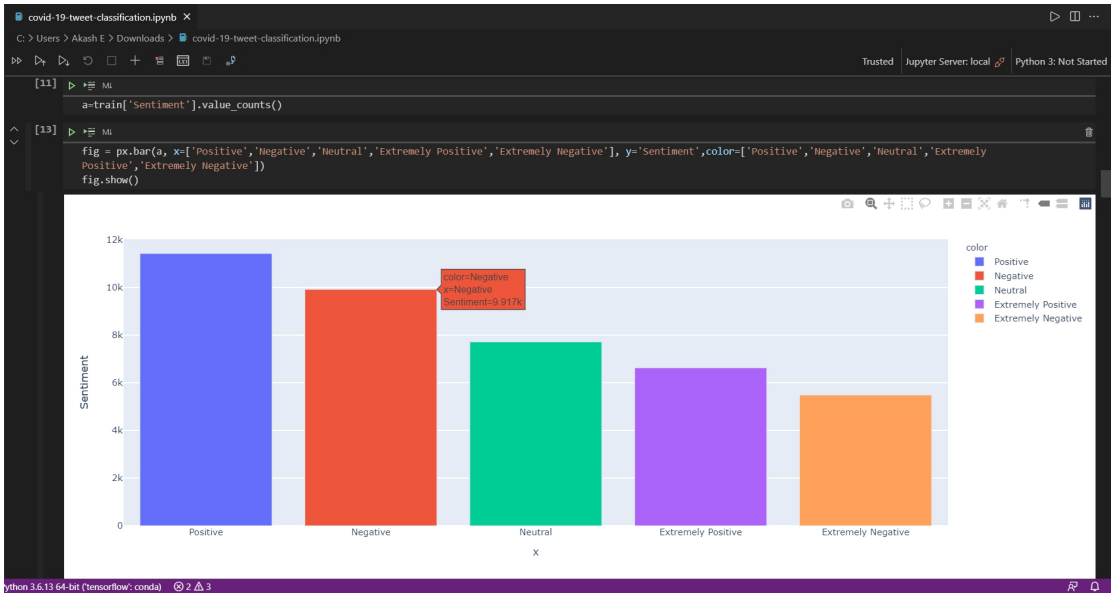
	UserName	ScreenName
count	41157.000000	41157.000000
mean	24377.000000	69329.000000
std	11881.146851	11881.146851
min	3799.000000	48751.000000
25%	14088.000000	59040.000000
50%	24377.000000	69329.000000
75%	34666.000000	79618.000000
max	44955.000000	89907.000000

[10]

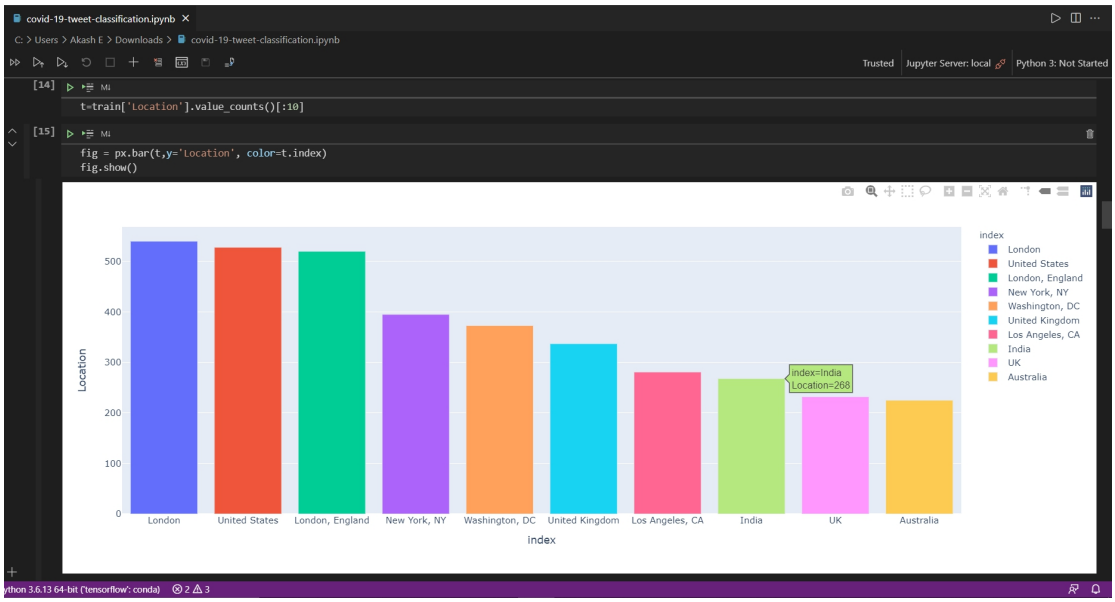
```
train.info()
```

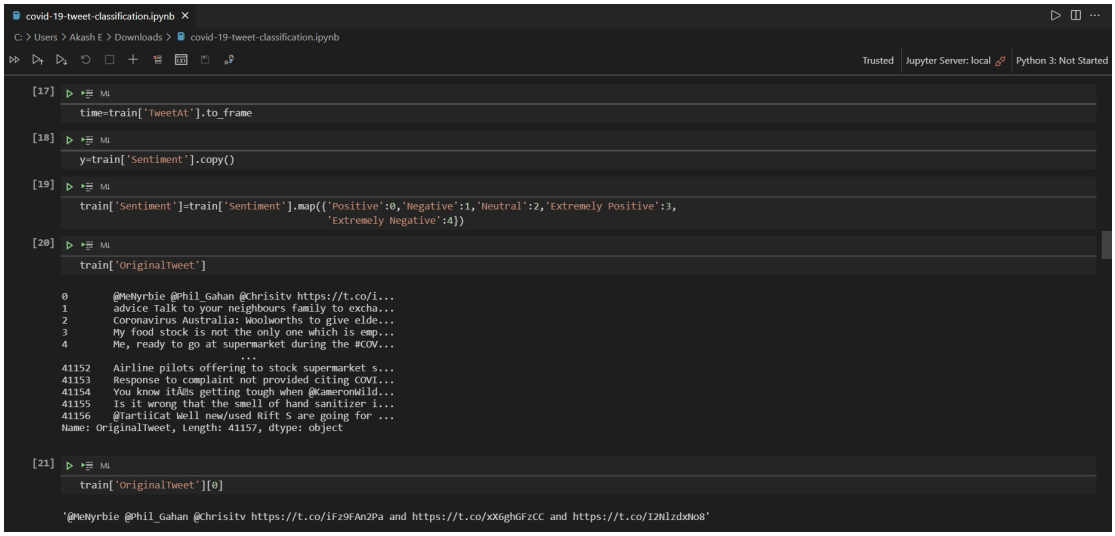
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 41157 entries, 0 to 41156
Data columns (total 6 columns):
 #   Column         Non-Null Count  Dtype 
---  ------         --------------  ----- 
 0   UserName       41157 non-null  int64 
 1   ScreenName     41157 non-null  int64 
 2   Location       32567 non-null  object
 3   TweetAt        41157 non-null  object
 4   OriginalTweet  41157 non-null  object
 5   Sentiment      41157 non-null  object
dtypes: int64(2), object(4)
memory usage: 1.9+ MB
```

Count of tweets for each class :



Count of tweets in each location :

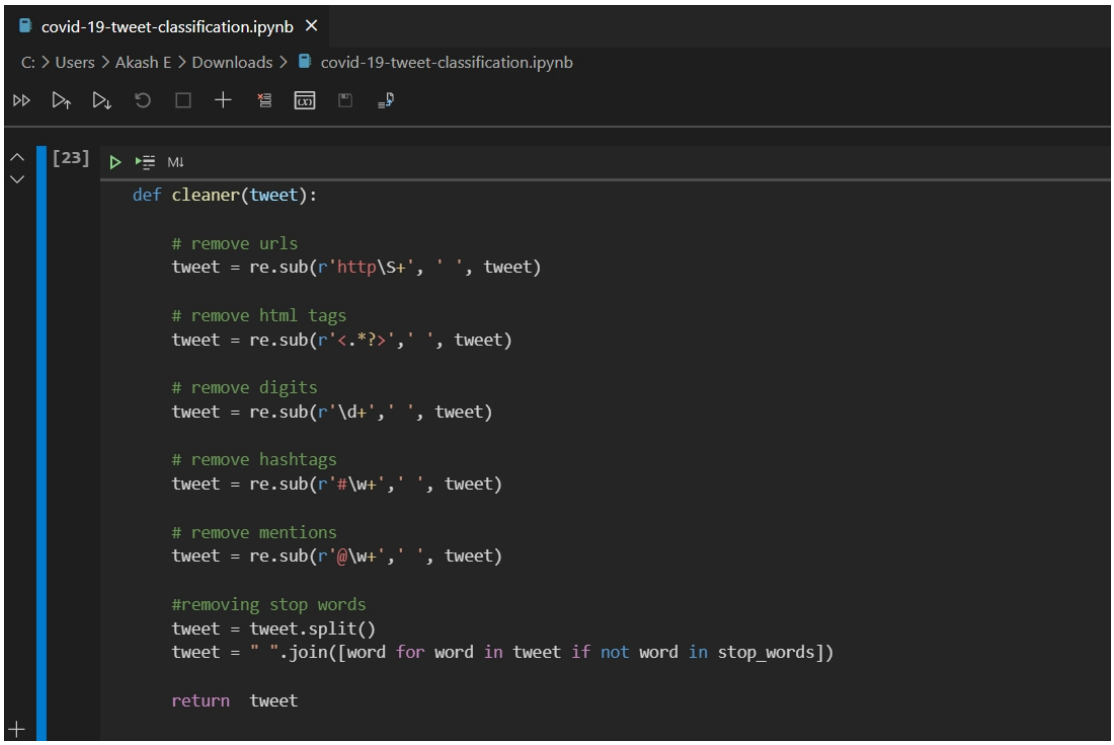




5.2 Data Pre-Processing :

In this module we clean the data to get only the necessary infromation.

Function to remove urls,hastags,digits,html tags etc :



covid-19-tweet-classification.ipynb

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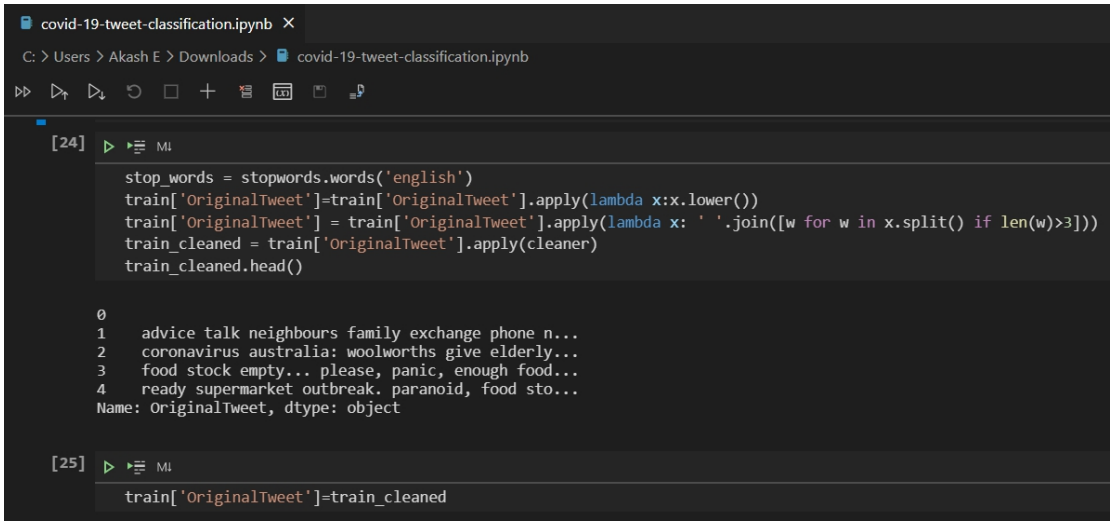
[23]

```
def cleaner(tweet):

    # remove urls
    tweet = re.sub(r'http\S+', ' ', tweet)

    # remove html tags
    tweet = re.sub(r'<.*?>',' ', tweet)

    # remove digits
    tweet = re.sub(r'\d+',' ', tweet)

    # remove hashtags
    tweet = re.sub(r'#\w+',' ', tweet)

    # remove mentions
    tweet = re.sub(r'@\w+',' ', tweet)

    #removing stop words
    tweet = tweet.split()
    tweet = " ".join([word for word in tweet if not word in stop_words])

    return  tweet
```



covid-19-tweet-classification.ipynb

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[24]

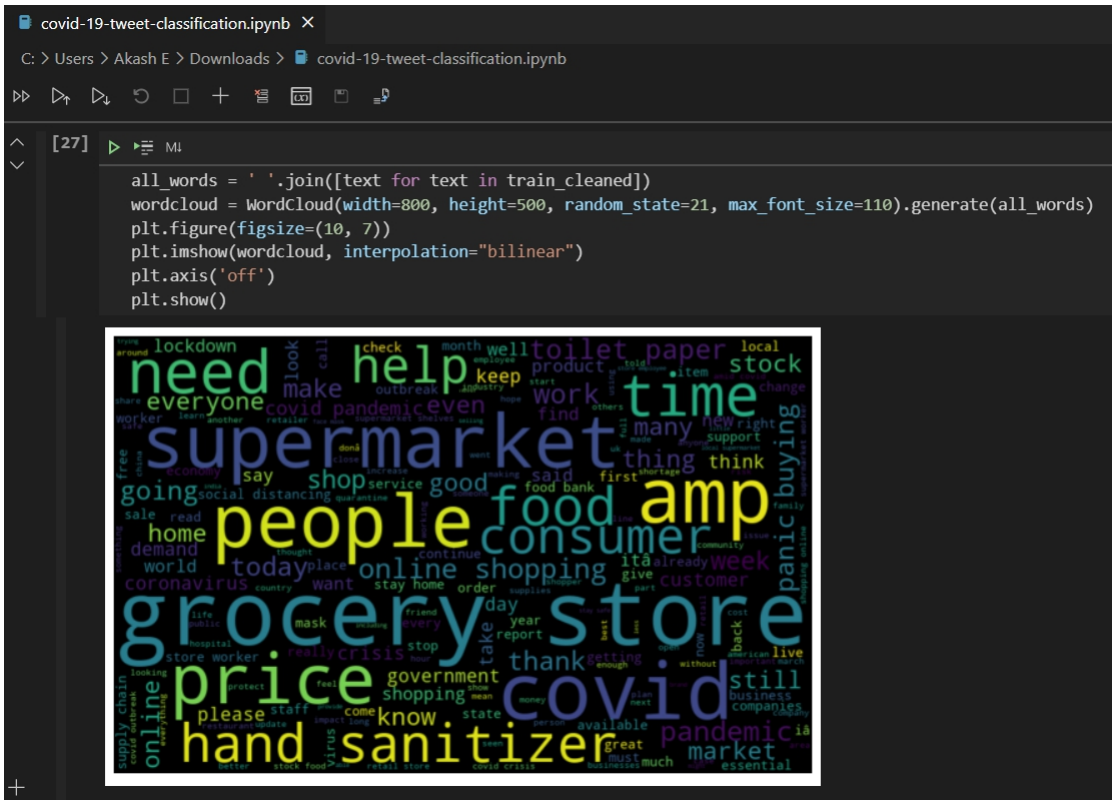
```
stop_words = stopwords.words('english')
train['OriginalTweet']=train['OriginalTweet'].apply(lambda x:x.lower())
train['OriginalTweet'] = train['OriginalTweet'].apply(lambda x: ' '.join([w for w in x.split() if len(w)>3]))
train_cleaned = train['OriginalTweet'].apply(cleaner)
train_cleaned.head()
```

```
0
1    advice talk neighbours family exchange phone n...
2    coronavirus australia: woolworths give elderly...
3    food stock empty... please, panic, enough food...
4    ready supermarket outbreak. paranoid, food sto...
Name: OriginalTweet, dtype: object
```

[25]

```
train['OriginalTweet']=train_cleaned
```

Word cloud of all the words in cleaned data :

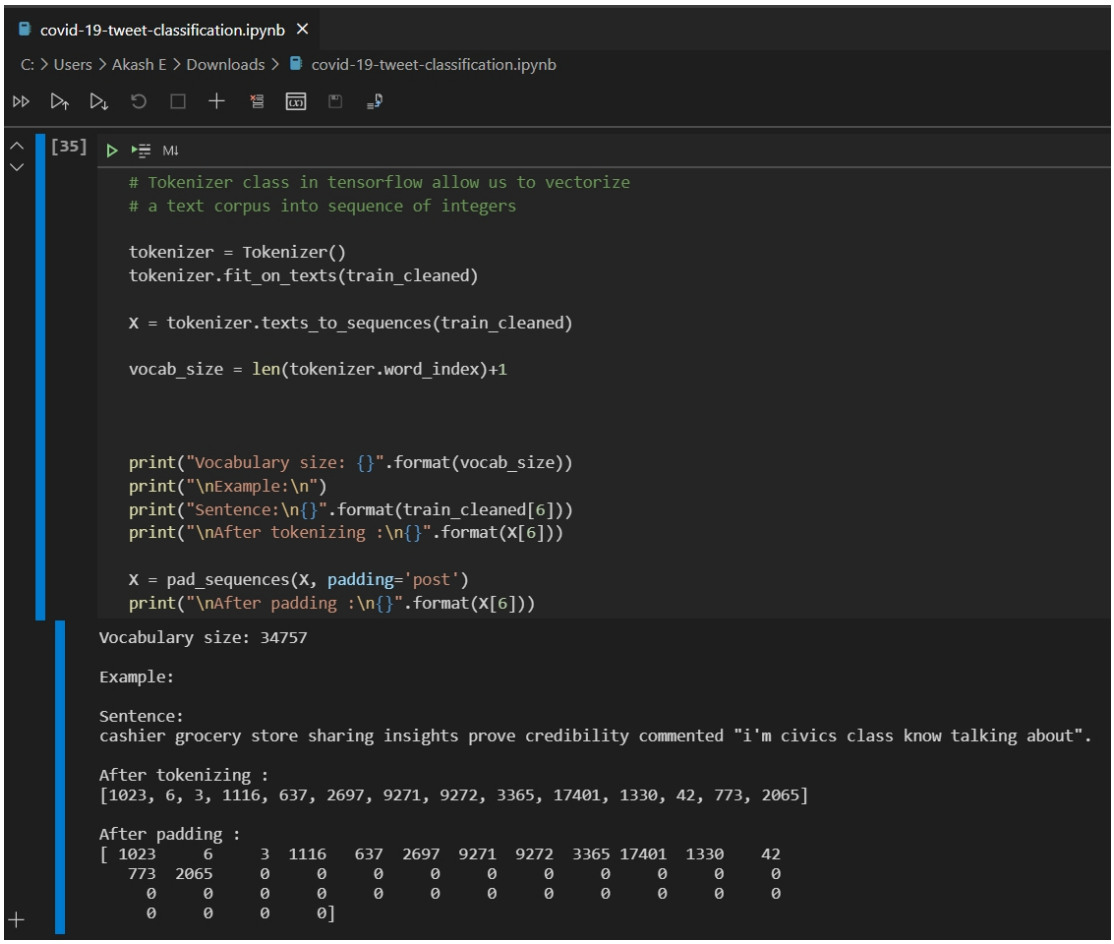


5.3 Word Embedding :

A word embedding is a learned representation for text where words that have the same meaning have a similar representation. Word embeddings are in fact a class of techniques where individual words are represented as real-valued vectors in a predefined vector space. Each word is mapped to one vector and the vector values are learned in a way that resembles a neural network, and hence the technique is often lumped into the field of deep learning.

Each of our word in the cleaned data is first mapped to a dictionary and the value of the index in the dictionary is given to the word. Then each sentence is padded with zeros in the end to keep every sentence the same size. This input is given to our **Keras Embedding layer** to perform the word embedding.

Tokenizing and Padding each sentence :



Labels are renamed as just Positive, Negative and Neutral :

5.4 Model Building and Training :

We build our model with the following parameters and train it in this module.

Parameter	Value
Epochs	2
Batch Size	32
Embedding Dimension	16
Loss Function	Sparse Categorical Cross-Entropy
Learning Rate	0.01
Optimizer	Adam

covid-19-tweet-classification.ipynb

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[37]

```
tf.keras.backend.clear_session()

# hyper parameters
EPOCHS = 2
BATCH_SIZE = 32
embedding_dim = 16
units = 256

model = tf.keras.Sequential([
    Layers.Embedding(vocab_size, embedding_dim, input_length=X.shape[1]),
    Layers.Bidirectional(Layers.LSTM(units,return_sequences=True)),
    Layers.GlobalMaxPool1D(),
    Layers.Dropout(0.4),
    Layers.Dense(64, activation="relu"),
    Layers.Dropout(0.4),
    Layers.Dense(3)
])


model.compile(loss=SparseCategoricalCrossentropy(from_logits=True),
              optimizer='adam',metrics=['accuracy']
             )

model.summary()
```

Model summary :

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
embedding (Embedding)        (None, 40, 16)            556112
_________________________________________________________________
bidirectional (Bidirectional (None, 40, 512)           559104
_________________________________________________________________
global_max_pooling1d (Global (None, 512)               0
_________________________________________________________________
dropout (Dropout)            (None, 512)               0
_________________________________________________________________
dense (Dense)                (None, 64)                32832
_________________________________________________________________
dropout_1 (Dropout)          (None, 64)                0
_________________________________________________________________
dense_1 (Dense)              (None, 3)                 195
=================================================================
Total params: 1,148,243
Trainable params: 1,148,243
Non-trainable params: 0
_________________________________________________________________
```

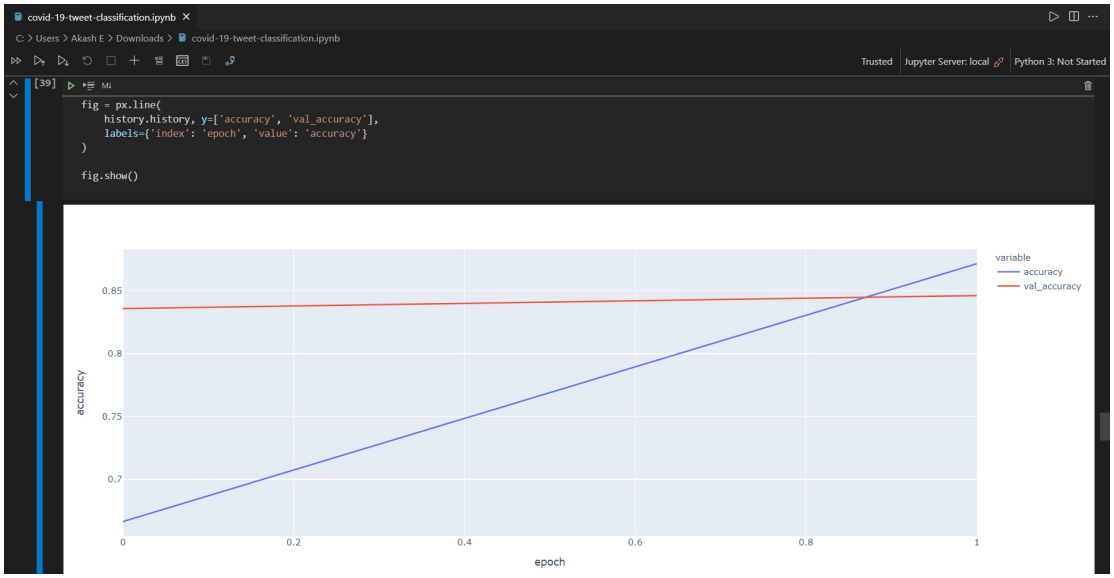
Training the model :

After two epochs, our model's validation accuracy seem to decrease. Hence we stop the training at the second epoch. If trained for 10 epochs, our model has a good training accuracy but performs poorly with test data. We got a training accuracy of 87%

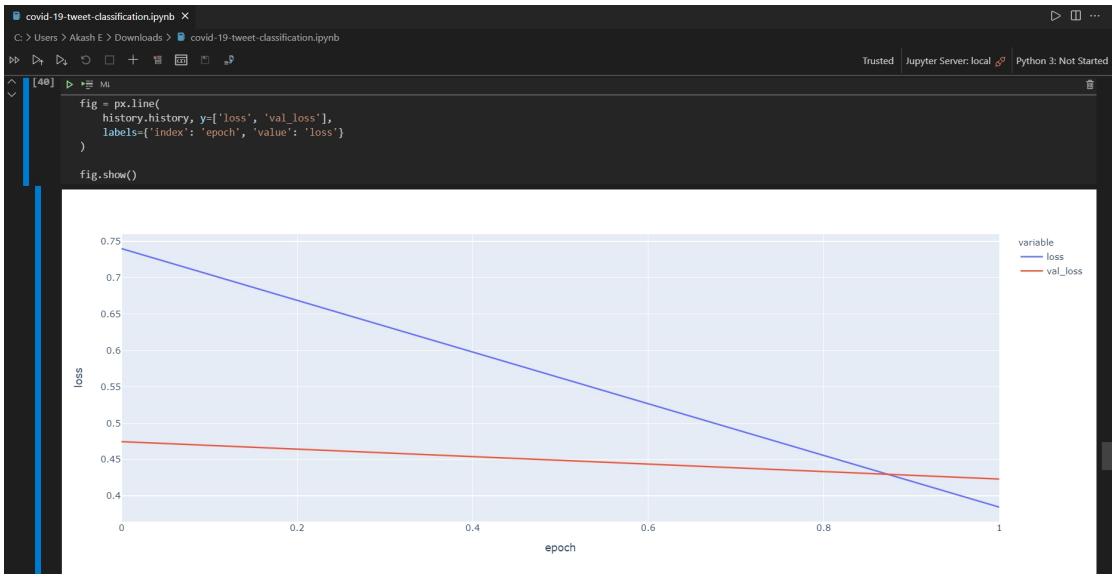
5.5 Result Analysis :

Here, we plot the training and testing results of our model.

Accuracy plot :



Loss plot :



Importing the testing data :

covid-19-tweet-classification.ipynb

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[41]

```
test=pd.read_csv("../input/covid-19-nlp-text-classification/Corona_NLP_test.csv")
```

[42]

```
test.head()
```

	UserName	ScreenName	Location	TweetAt	OriginalTweet	Sentiment
0	1	44953	NYC	02-03-2020	TRENDING: New Yorkers encounter empty supermar...	Extremely Negative
1	2	44954	Seattle, WA	02-03-2020	When I couldn't find hand sanitizer at Fred Me...	Positive
2	3	44955	NaN	02-03-2020	Find out how you can protect yourself and love...	Extremely Positive
3	4	44956	Chicagoland	02-03-2020	#Panic buying hits #NewYork City as anxious sh...	Negative
4	5	44957	Melbourne, Victoria	03-03-2020	#toiletpaper #dunnypaper #coronavirus #coronav...	Neutral

[43]

```
test.shape
```

```
(3798, 6)
```

covid-19-tweet-classification.ipynb

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[44]
```
X_test = test['OriginalTweet'].copy()
y_test = test['Sentiment'].copy()

X_test = X_test.apply(cleaner)

X_test = tokenizer.texts_to_sequences(X_test)

X_test = pad_sequences(X_test, padding='post')

y_test.replace(encoding, inplace=True)
```

[45]
```
pred = model.predict_classes(X_test)
```

[46]
```
pred
```

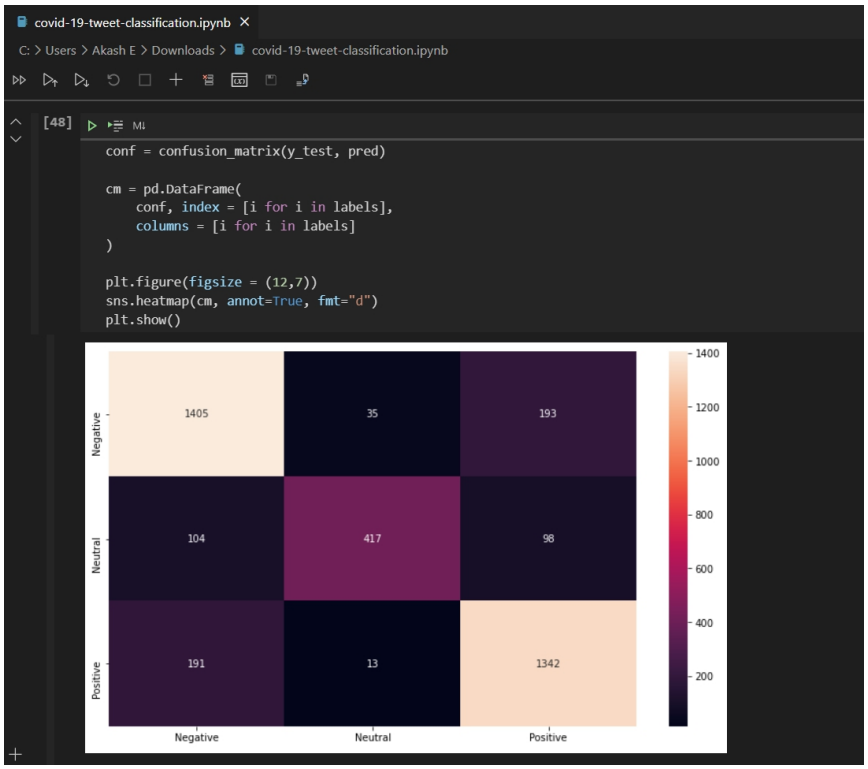
```
array([0, 2, 2, ..., 1, 0, 2])
```

[47]
```
loss, acc = model.evaluate(X_test,y_test,verbose=0)
print('Test loss: {}'.format(loss))
print('Test Accuracy: {}'.format(acc))
```

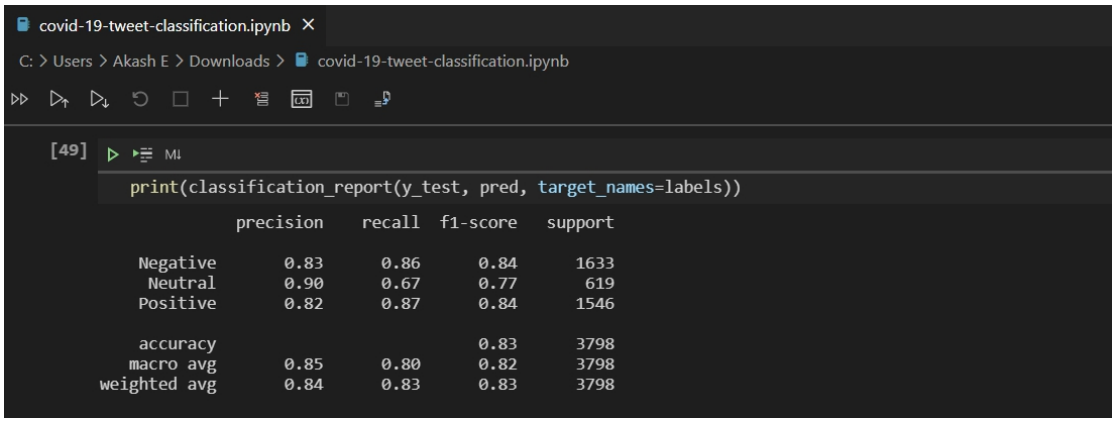
```
Test loss: 0.47204768657684326
Test Accuracy: 0.8330700397491455
```

From the above code we can see that our model has a **testing accuracy of 83%** which is pretty good.

Confusion Matrix :



Classification Report :



Training Accuracy	87%
Validation Accuracy	84%
Testing Accuracy	83%

6. CONCLUSION :

Hence we used the Bidirectional LSTM to perform sentiment analysis on the Covid-19 twitter dataset. We also got good training and testing accuracies while doing so.