covid-19-tweets-lstm

June 18, 2023

[2]:

```
# This Python 3 environment comes with many helpful analytics libraries␣
 ↪installed
# It is defined by the kaggle/python Docker image: https://github.com/kaggle/
 ↪docker-python
# For example, here's several helpful packages to load

import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)

# Input data files are available in the read-only "../input/" directory
# For example, running this (by clicking run or pressing Shift+Enter) will list␣
 ↪all files under the input directory

import os
for dirname, _, filenames in os.walk('/kaggle/input'):
    for filename in filenames:
        print(os.path.join(dirname, filename))

# You can write up to 20GB to the current directory (/kaggle/working/) that␣
 ↪gets preserved as output when you create a version using "Save & Run All"
# You can also write temporary files to /kaggle/temp/, but they won't be saved␣
 ↪outside of the current session
```

```
/kaggle/input/covid-19-nlp-text-classification/Corona_NLP_test.csv
/kaggle/input/covid-19-nlp-text-classification/Corona_NLP_train.csv
```

[3]:

```
import warnings
warnings.filterwarnings("ignore")
```

[4]:

```
# tensorflow dependencies:
import tensorflow as tf
from tensorflow import keras
print(f"Tensorflow Version: {tf.__version__}")
```

```
Tensorflow Version: 2.12.0
```

1 1. Dataset

[5]:
```
train = pd.read_csv("/kaggle/input/covid-19-nlp-text-classification/
 ↪Corona_NLP_train.csv", encoding= 'latin-1')
```

[6]:
```
train.head()
```

[6]:
```
   UserName  ScreenName   Location     TweetAt  \
0      3799       48751     London  16-03-2020
1      3800       48752         UK  16-03-2020
2      3801       48753  Vagabonds  16-03-2020
3      3802       48754        NaN  16-03-2020
4      3803       48755        NaN  16-03-2020

                                       OriginalTweet           Sentiment
0  @MeNyrbie @Phil_Gahan @Chrisitv https://t.co/i…             Neutral
1  advice Talk to your neighbours family to excha…            Positive
2  Coronavirus Australia: Woolworths to give elde…            Positive
3  My food stock is not the only one which is emp…            Positive
4  Me, ready to go at supermarket during the #COV…  Extremely Negative
```

[7]:
```
test=pd.read_csv('/kaggle/input/covid-19-nlp-text-classification/
 ↪Corona_NLP_test.csv',  encoding= 'latin-1')
```

[8]:
```
test.head()
```

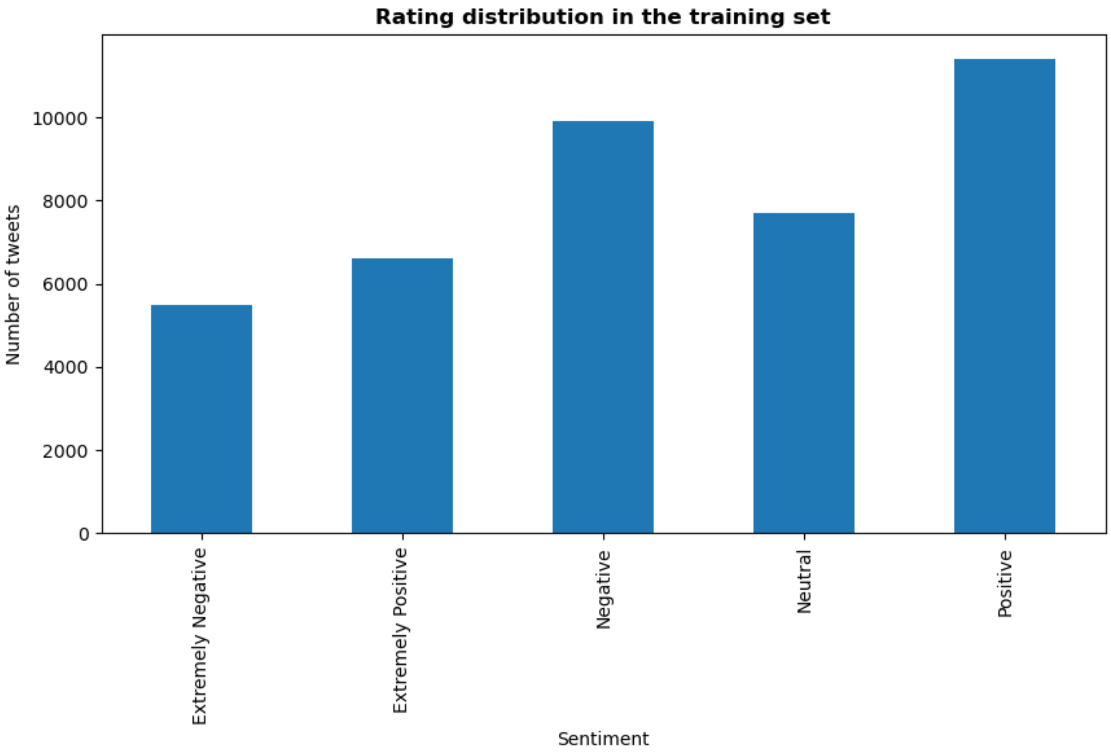
[8]:
```
   UserName  ScreenName             Location     TweetAt  \
0         1       44953                  NYC  02-03-2020
1         2       44954          Seattle, WA  02-03-2020
2         3       44955                  NaN  02-03-2020
3         4       44956          Chicagoland  02-03-2020
4         5       44957  Melbourne, Victoria  03-03-2020

                                       OriginalTweet           Sentiment
0  TRENDING: New Yorkers encounter empty supermar…  Extremely Negative
1  When I couldn't find hand sanitizer at Fred Me…            Positive
2  Find out how you can protect yourself and love…  Extremely Positive
3  #Panic buying hits #NewYork City as anxious sh…            Negative
4  #toiletpaper #dunnypaper #coronavirus #coronav…             Neutral
```

2 2. Data Exploration:

[9]:
```
import matplotlib.pyplot as plt
import seaborn as sns
```

[10]:
```
train['Sentiment'].value_counts().sort_index().plot.bar(figsize=(10,5))
plt.title('Rating distribution in the training set', fontweight="bold")
plt.xlabel('Sentiment')
plt.ylabel('Number of tweets')
plt.show()
```



2.1 a. Shape of Data

[11]:
```
train.shape
```

[11]:
```
(41157, 6)
```

[12]:
```
test.shape
```

[12]:
```
(3798, 6)
```

2.2 b. Size of Data

[13]:
```
train.size
```

[13]:
```
246942
```

[14]:

```
test.size
```

[14]:

```
22788
```

2.3 c. Attributes

[15]:

```
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
```

[16]:

```
test.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 3798 entries, 0 to 3797
Data columns (total 6 columns):
 #   Column         Non-Null Count  Dtype
---  ------         --------------  -----
 0   UserName       3798 non-null   int64
 1   ScreenName     3798 non-null   int64
 2   Location       2964 non-null   object
 3   TweetAt        3798 non-null   object
 4   OriginalTweet  3798 non-null   object
 5   Sentiment      3798 non-null   object
dtypes: int64(2), object(4)
memory usage: 178.2+ KB
```

2.4 d. Properties

[17]:

```
train.describe()
```

[17]:

```
           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
```

```
[18]: test.describe()
```

```
[18]:          UserName    ScreenName
      count  3798.000000   3798.000000
      mean   1899.500000  46851.500000
      std    1096.532489   1096.532489
      min       1.000000  44953.000000
      25%     950.250000  45902.250000
      50%    1899.500000  46851.500000
      75%    2848.750000  47800.750000
      max    3798.000000  48750.000000
```

2.5 e. EDA

```
[19]: train.columns
```

```
[19]: Index(['UserName', 'ScreenName', 'Location', 'TweetAt', 'OriginalTweet',
             'Sentiment'],
            dtype='object')
```

```
[20]: test.columns
```

```
[20]: Index(['UserName', 'ScreenName', 'Location', 'TweetAt', 'OriginalTweet',
             'Sentiment'],
            dtype='object')
```

```
[21]: len(train)
```

```
[21]: 41157
```

```
[22]: len(test)
```

```
[22]: 3798
```

```
[23]: train.dtypes
```

```
[23]: UserName          int64
      ScreenName        int64
      Location         object
      TweetAt          object
      OriginalTweet    object
      Sentiment        object
```

```
dtype: object
```

```
[24]: test.dtypes
```

```
[24]: UserName          int64
      ScreenName        int64
      Location         object
      TweetAt          object
      OriginalTweet    object
      Sentiment        object
      dtype: object
```

2.6 f. NULL Values

```
[25]: train.isna().sum()
```

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

```
[26]: train.isnull().sum()/len(train)*100
```

```
[26]: UserName          0.000000
      ScreenName        0.000000
      Location         20.871298
      TweetAt           0.000000
      OriginalTweet     0.000000
      Sentiment         0.000000
      dtype: float64
```

```
[27]: test.isna().sum()
```

```
[27]: UserName           0
      ScreenName         0
      Location         834
      TweetAt            0
      OriginalTweet      0
      Sentiment          0
      dtype: int64
```

```
[28]: test.isnull().sum()/len(test)*100
```

```
[28]: UserName          0.000000
      ScreenName        0.000000
      Location         21.958926
      TweetAt           0.000000
      OriginalTweet     0.000000
      Sentiment         0.000000
      dtype: float64
```

2.7 g. Unique

```
[29]: train.nunique()
```

```
[29]: UserName         41157
      ScreenName       41157
      Location         12220
      TweetAt             30
      OriginalTweet    41157
      Sentiment            5
      dtype: int64
```

```
[30]: train.nunique().sum()
```

```
[30]: 135726
```

```
[31]: test.nunique()
```

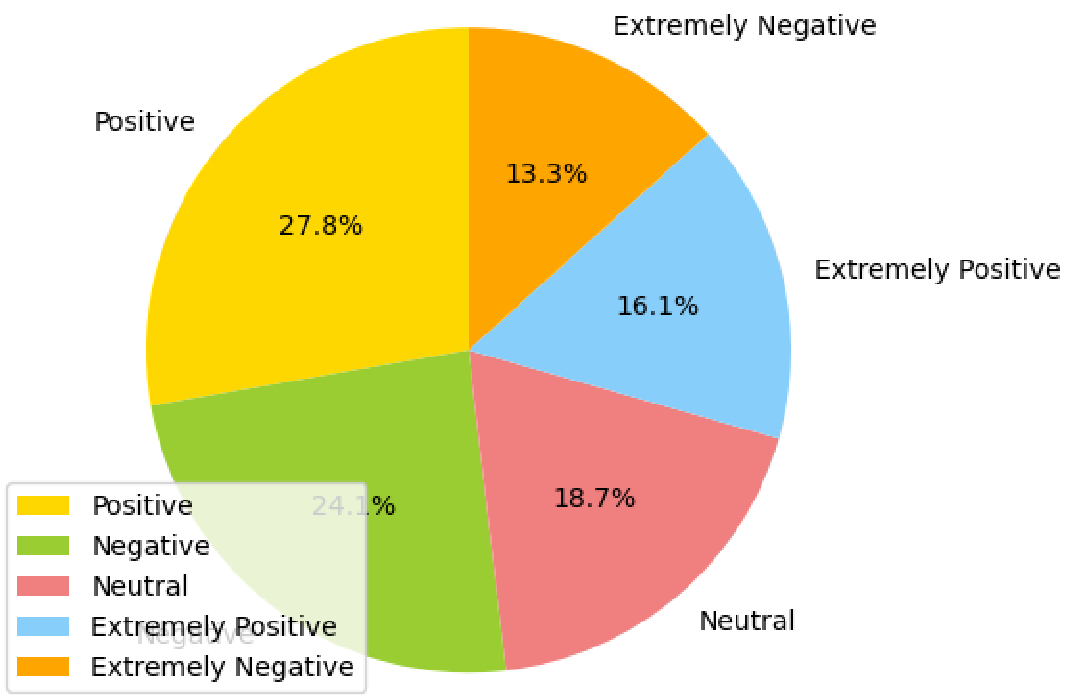
```
[31]: UserName         3798
      ScreenName       3798
      Location         1717
      TweetAt            15
      OriginalTweet    3798
      Sentiment           5
      dtype: int64
```

```
[32]: test.nunique().sum()
```

```
[32]: 13131
```

```
[33]: sentiment_counts = train['Sentiment'].value_counts()
      labels = ['Positive', 'Negative', 'Neutral', 'Extremely Positive', 'Extremely␣
        ↪Negative']
      colors = ['gold', 'yellowgreen', 'lightcoral', 'lightskyblue', 'orange']

      plt.pie(sentiment_counts, labels=labels, colors=colors, autopct='%1.1f%%',␣
        ↪startangle=90)
      plt.axis('equal')
      plt.legend()
plt.show()
```



3 3. Data Pre-processing

3.1 a. NULL Values

[34]:
```
total_null_train = train.isnull().sum().sort_values(ascending = False)
percentage_null_train=((train.isnull().sum()/train.isnull().count())*100).
 ↪sort_values(ascending = False)

print("Total records = ", train.shape[0])

missing_data = pd.concat([total_null_train, percentage_null_train.round(2)],␣
 ↪axis=1, keys=['Total Missing', 'In Percent'])
missing_data.head()
```

```
Total records =  41157
```

[34]:
```
            Total Missing  In Percent
Location             8590       20.87
UserName                0        0.00
ScreenName              0        0.00
TweetAt                 0        0.00
```

```
OriginalTweet              0        0.00
```

[35]:

```
total_null_test = test.isnull().sum().sort_values(ascending = False)
percentage_null_test=((test.isnull().sum()/test.isnull().count())*100).
 ↪sort_values(ascending = False)

print("Total records = ", test.shape[0])

missing_data = pd.concat([total_null_test, percentage_null_test.round(2)],␣
 ↪axis=1, keys=['Total Missing', 'In Percent'])
missing_data.head()
```

```
Total records =  3798
```

[35]:

```
               Total Missing  In Percent
Location                 834       21.96
UserName                   0        0.00
ScreenName                 0        0.00
TweetAt                    0        0.00
OriginalTweet              0        0.00
```

3.2 b. Reduction of Data

[36]:

```
train['Sentiment'].nunique()
```

[36]:

```
5
```

[37]:

```
train['Sentiment'].value_counts()
```

[37]:

```
Positive              11422
Negative               9917
Neutral                7713
Extremely Positive     6624
Extremely Negative     5481
Name: Sentiment, dtype: int64
```

[38]:

```
test['Sentiment'].nunique()
```

[38]:

```
5
```

[39]:

```
test['Sentiment'].value_counts()
```

[39]:

```
Negative              1041
Positive               947
Neutral                619
Extremely Positive     599
Extremely Negative     592
```

```
Name: Sentiment, dtype: int64
```

3.3 Train, Test EDA

[40]:

```
df=pd.read_csv('/kaggle/input/covid-19-nlp-text-classification/Corona_NLP_train.
 ↪csv', encoding='latin1')
df
```

[40]:

```
       UserName  ScreenName                     Location     TweetAt  \
0          3799       48751                       London  16-03-2020
1          3800       48752                           UK  16-03-2020
2          3801       48753                    Vagabonds  16-03-2020
3          3802       48754                          NaN  16-03-2020
4          3803       48755                          NaN  16-03-2020
…           …           …                            …         …
41152     44951       89903  Wellington City, New Zealand  14-04-2020
41153     44952       89904                          NaN  14-04-2020
41154     44953       89905                          NaN  14-04-2020
41155     44954       89906                          NaN  14-04-2020
41156     44955       89907  i love you so much || he/him  14-04-2020

                                           OriginalTweet           Sentiment
0      @MeNyrbie @Phil_Gahan @Chrisitv https://t.co/i…             Neutral
1      advice Talk to your neighbours family to excha…            Positive
2      Coronavirus Australia: Woolworths to give elde…            Positive
3      My food stock is not the only one which is emp…            Positive
4      Me, ready to go at supermarket during the #COV…  Extremely Negative
…                                                    …                   …
41152  Airline pilots offering to stock supermarket s…             Neutral
41153  Response to complaint not provided citing COVI…  Extremely Negative
41154  You know itÂ s getting tough when @KameronWild…            Positive
41155  Is it wrong that the smell of hand sanitizer i…             Neutral
41156  @TartiiCat Well new/used Rift S are going for …            Negative

[41157 rows x 6 columns]
```

[41]:

```
# function to keep only Text and label:
def create_data(df):
    x=df['OriginalTweet']
    y=df['Sentiment']
    df=pd.concat((x,y),axis=1, keys=['texts','labels'])
    return df
```

[42]:

```
%%time
#reduced data:
df=create_data(df)
df
```

```
CPU times: user 1.85 ms, sys: 0 ns, total: 1.85 ms
Wall time: 1.64 ms
```

```
[42]:                                                   texts              labels
      0      @MeNyrbie @Phil_Gahan @Chrisitv https://t.co/i…            Neutral
      1      advice Talk to your neighbours family to excha…           Positive
      2      Coronavirus Australia: Woolworths to give elde…           Positive
      3      My food stock is not the only one which is emp…           Positive
      4      Me, ready to go at supermarket during the #COV…  Extremely Negative
      …                                                   …                  …
      41152  Airline pilots offering to stock supermarket s…            Neutral
      41153  Response to complaint not provided citing COVI…  Extremely Negative
      41154  You know itÂ s getting tough when @KameronWild…           Positive
      41155  Is it wrong that the smell of hand sanitizer i…            Neutral
      41156  @TartiiCat Well new/used Rift S are going for …           Negative

      [41157 rows x 2 columns]
```

```
[43]: overview=pd.concat([df.isnull().sum(),df.nunique()],axis=1,keys=['Null␣
        ↪Counts','Cardinality'])
      overview
```

```
[43]:         Null Counts  Cardinality
      texts             0        41157
      labels            0            5
```

```
[44]: from sklearn.model_selection import train_test_split
      x_train, x_test, y_train, y_test = train_test_split(df['texts'], df['labels'],␣
        ↪test_size=0.2, random_state=42)

      x_train.shape, y_train.shape, x_test.shape, y_test.shape
```

```
[44]: ((32925,), (32925,), (8232,), (8232,))
```

```
[45]: # text before cleaning:
      x_train.iloc[0]
```

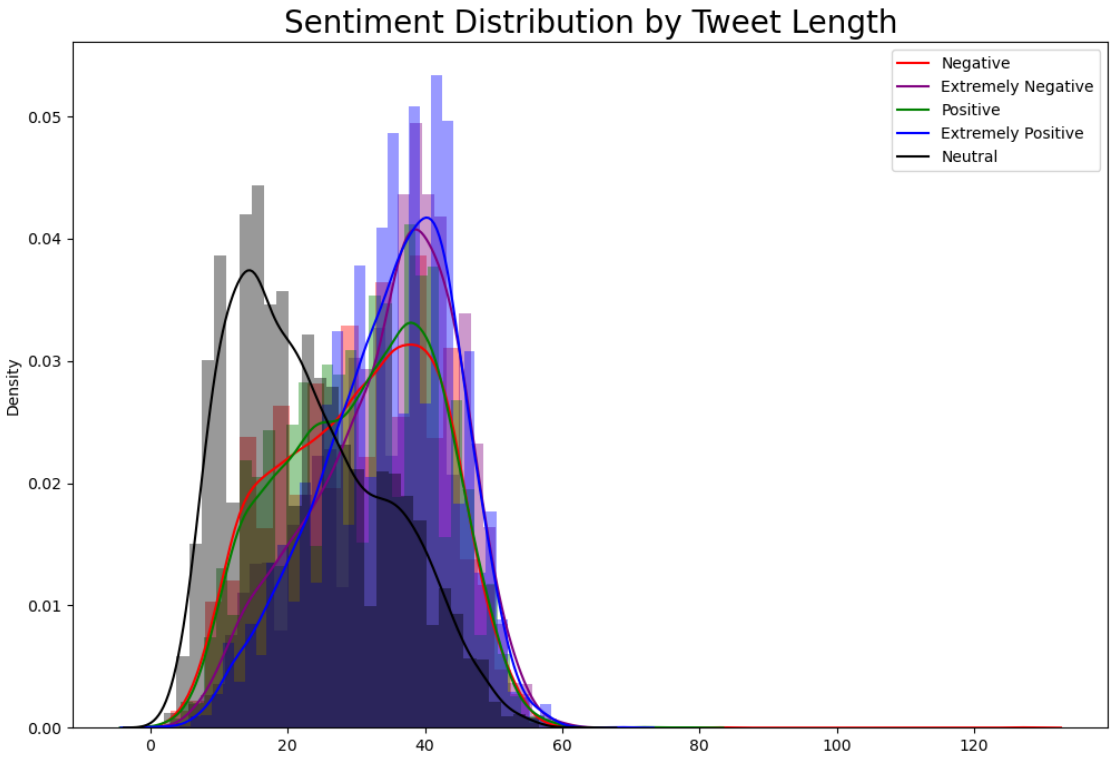
```
[45]: 'Unemployment claims made online in Virginia this week:\r\r\n\r\r\nMonday:
      426\r\r\nTuesday: 2,150\r\r\n\r\r\nAnd the numbers are going to get bigger.
      https://t.co/fUeg2RL2dl'
```

```
[46]: import warnings
      warnings.filterwarnings('ignore')
```

```
[47]: text_len = np.array([len(tweet.split(' ')) for tweet in x_train])
```

[48]:

```
plt.subplots(figsize=(12,8))
sns.distplot(text_len[(y_train == 'Negative')], color='r')
sns.distplot(text_len[(y_train == 'Extremely Negative')], color='purple')
sns.distplot(text_len[(y_train == 'Positive')], color='g')
sns.distplot(text_len[(y_train == 'Extremely Positive')], color='blue')
sns.distplot(text_len[y_train == 'Neutral'], color='black')
plt.legend(['Negative', 'Extremely Negative',
            'Positive', 'Extremely Positive',
            'Neutral'])
plt.title('Sentiment Distribution by Tweet Length', fontsize=20)
plt.show()
```



3.4 c. Data Cleaning

[49]:

```
x_train
```

[49]:

```
8191     Unemployment claims made online in Virginia th…
3725     Panic-buying in response to #Covid19 could hav…
22759    E-cigarette users and tobacco smokers are more…
15010    You just know that a YouTube prankster is goin…
39142    "Our appetite for meat has to change, but we a…
                              …
```

```
6265     Minnesota classifies grocery store workers as …
11284    US Senator @ewarren has asked for information …
38158    Just commented on @thejournal_ie: Poll: Are yo…
860      My wife got laid off yesterday because the sma…
15795    Humanity is doomed\r\r\n#coronavirus #coronacr…
Name: texts, Length: 32925, dtype: object
```

[50]:

```
y_train
```

[50]:

```
8191               Negative
3725     Extremely Negative
22759              Negative
15010               Neutral
39142    Extremely Negative
                ...
6265               Negative
11284              Negative
38158    Extremely Negative
860                 Neutral
15795    Extremely Negative
Name: labels, Length: 32925, dtype: object
```

[51]:

```
# dependencies:
import nltk
nltk.download('wordnet')
nltk.download('stopwords')
from nltk.corpus import stopwords
from nltk.stem import WordNetLemmatizer
from nltk.tokenize import TweetTokenizer
import re
from nltk.stem import WordNetLemmatizer
from nltk.tokenize import word_tokenize

# initiating lemmatizer(kaggle specific):
# Define a install path for nltk
if os.environ.get('KAGGLE_KERNEL_RUN_TYPE', ''):
    nltk_path='/kaggle/working'
else:
    nltk_path="{}".format(os.getcwd())

isnltk_installed = os.path.isdir(f'{nltk_path}/nltk_data/corpora/wordnet')

# Install relevent libraries to nltk path
if isnltk_installed:
    nltk.data.path.append(f'{nltk_path}/nltk_data')
else:
    # Make directort name 'nlrk_data' in current work directory '/kaggle/
↪working/'
    !mkdir nltk_data
    # Download neccessaty package as .zip file ('corpora' directory are␣
↪automatically created)
    nltk.download('wordnet', f"{nltk_path}/nltk_data")
    nltk.download('omw-1.4', f"{nltk_path}/nltk_data/")
    # Unzip .zip file in folder '/kaggle/working/nltk_data/corpora'
    !unzip /kaggle/working/nltk_data/corpora/wordnet.zip -d /kaggle/working/
↪nltk_data/corpora
    !unzip /kaggle/working/nltk_data/corpora/omw-1.4.zip -d /kaggle/working/
↪nltk_data/corpora
    # Add custom location nltk file data path
    nltk.data.path.append(f'{nltk_path}/nltk_data')
```

```
[nltk_data] Downloading package wordnet to /usr/share/nltk_data…
[nltk_data]   Package wordnet is already up-to-date!
[nltk_data] Downloading package stopwords to /usr/share/nltk_data…
[nltk_data]   Package stopwords is already up-to-date!
[nltk_data] Downloading package wordnet to
[nltk_data]     /kaggle/working/nltk_data…
[nltk_data] Downloading package omw-1.4 to
[nltk_data]     /kaggle/working/nltk_data/…
Archive:  /kaggle/working/nltk_data/corpora/wordnet.zip
   creating: /kaggle/working/nltk_data/corpora/wordnet/
  inflating: /kaggle/working/nltk_data/corpora/wordnet/lexnames
  inflating: /kaggle/working/nltk_data/corpora/wordnet/data.verb
  inflating: /kaggle/working/nltk_data/corpora/wordnet/index.adv
  inflating: /kaggle/working/nltk_data/corpora/wordnet/adv.exc
  inflating: /kaggle/working/nltk_data/corpora/wordnet/index.verb
  inflating: /kaggle/working/nltk_data/corpora/wordnet/cntlist.rev
  inflating: /kaggle/working/nltk_data/corpora/wordnet/data.adj
  inflating: /kaggle/working/nltk_data/corpora/wordnet/index.adj
  inflating: /kaggle/working/nltk_data/corpora/wordnet/LICENSE
  inflating: /kaggle/working/nltk_data/corpora/wordnet/citation.bib
  inflating: /kaggle/working/nltk_data/corpora/wordnet/noun.exc
  inflating: /kaggle/working/nltk_data/corpora/wordnet/verb.exc
  inflating: /kaggle/working/nltk_data/corpora/wordnet/README
  inflating: /kaggle/working/nltk_data/corpora/wordnet/index.sense
  inflating: /kaggle/working/nltk_data/corpora/wordnet/data.noun
  inflating: /kaggle/working/nltk_data/corpora/wordnet/data.adv
  inflating: /kaggle/working/nltk_data/corpora/wordnet/index.noun
  inflating: /kaggle/working/nltk_data/corpora/wordnet/adj.exc
Archive:  /kaggle/working/nltk_data/corpora/omw-1.4.zip
   creating: /kaggle/working/nltk_data/corpora/omw-1.4/
   creating: /kaggle/working/nltk_data/corpora/omw-1.4/fin/
  inflating: /kaggle/working/nltk_data/corpora/omw-1.4/fin/LICENSE
```

```
 inflating: /kaggle/working/nltk_data/corpora/omw-1.4/fin/citation.bib
 inflating: /kaggle/working/nltk_data/corpora/omw-1.4/fin/wn-data-fin.tab
  creating: /kaggle/working/nltk_data/corpora/omw-1.4/heb/
 inflating: /kaggle/working/nltk_data/corpora/omw-1.4/heb/LICENSE
 inflating: /kaggle/working/nltk_data/corpora/omw-1.4/heb/citation.bib
 inflating: /kaggle/working/nltk_data/corpora/omw-1.4/heb/README
 inflating: /kaggle/working/nltk_data/corpora/omw-1.4/heb/wn-data-heb.tab
  creating: /kaggle/working/nltk_data/corpora/omw-1.4/slv/
 inflating: /kaggle/working/nltk_data/corpora/omw-1.4/slv/LICENSE
 inflating: /kaggle/working/nltk_data/corpora/omw-1.4/slv/citation.bib
 inflating: /kaggle/working/nltk_data/corpora/omw-1.4/slv/README
 inflating: /kaggle/working/nltk_data/corpora/omw-1.4/slv/wn-data-slv.tab
  creating: /kaggle/working/nltk_data/corpora/omw-1.4/ita/
 inflating: /kaggle/working/nltk_data/corpora/omw-1.4/ita/LICENSE
 inflating: /kaggle/working/nltk_data/corpora/omw-1.4/ita/citation.bib
 inflating: /kaggle/working/nltk_data/corpora/omw-1.4/ita/wn-data-ita.tab
extracting: /kaggle/working/nltk_data/corpora/omw-1.4/ita/README
  creating: /kaggle/working/nltk_data/corpora/omw-1.4/nor/
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```

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```

3.4.1 0. Emoji Removing

3.4.2 i. Hashtag Removal,

3.4.3 ii. Mentions Removal,

3.4.4 iii. URL Removal,

3.4.5 iv. Stopwords Removal,

3.4.6 v. lowercase

3.4.7 vi. Punctuations Removal etc…

[52]:

```
# function for NLP:
def nlp(text):
  def remove_emoji(text):
    emoji_pattern = re.compile(
      '['
      u'\U0001F600-\U0001F64F'  # emoticons
      u'\U0001F300-\U0001F5FF'  # symbols & pictographs
      u'\U0001F680-\U0001F6FF'  # transport & map symbols
      u'\U0001F1E0-\U0001F1FF'  # flags
      u'\U00002702-\U000027B0'
      u'\U000024C2-\U0001F251'
      ']+',
      flags=re.UNICODE)
    return emoji_pattern.sub(r'', text)
  def lemmatize(text):
    lemmatizer = WordNetLemmatizer()
    tokenizer = TweetTokenizer()
    words = tokenizer.tokenize(text)
    words = [lemmatizer.lemmatize(word) for word in words if word not in␣
 ↪stopwords.words('english')]
    return words
  text = remove_emoji(text)
  text = str(text).lower()
  text = re.sub(r'https?://\S+|www\.\S+', '', text)
  text = re.sub(r'RT[\s]+', '', text)
  text = re.sub(r'@\S+', '', text)
  text = re.sub(r'#', '', text)
  text = re.sub(r'\[', '', text)
  text = re.sub(r'\]', '', text)
  text = re.sub('â\\x92', "'", text)
  text = re.sub('â\S+', '', text)
  text = re.sub('\.+', '.', text)
  text = re.sub('&amp;', 'and', text)
  text = re.sub("let's", 'let us', text)
  text = re.sub("'s", ' is', text)
  text = re.sub("'re", ' are', text)
  text = re.sub("ain't", 'am not', text)
  text = re.sub("won't", 'will not', text)
  text = re.sub("n't", ' not', text)
  text = re.sub("'ve", ' have', text)
  text = re.sub("y'all", "you all", text)
  text = re.sub("'ll", ' will', text)
  text = re.sub("i'd", 'i would', text)
  text = re.sub("i'm", 'i am', text)
  text = re.sub(r"[^a-z<>!?\s]+", '', text)
  text = re.sub('covid\S*', 'coronavirus', text)
  text = re.sub('corona\S*', 'coronavirus', text)
  text = re.sub(r'\s+', ' ', text)
  text = lemmatize(text)
  return text
```

[53]:

```
%%time
import tqdm.notebook as tq
x_train_clean = np.array([nlp(text) for text in tq.tqdm(x_train.values,␣
 ↪desc='Progress')], dtype='O')
```

```
x_test_clean = np.array([nlp(sent) for sent in tq.tqdm(x_test.values,␣
 ↪desc='Progress')], dtype='O')
```

```
Progress:   0%|          | 0/32925 [00:00<?, ?it/s]

Progress:   0%|          | 0/8232 [00:00<?, ?it/s]

CPU times: user 2min 30s, sys: 20.6 s, total: 2min 51s
Wall time: 2min 51s
```

[54]:
```
# text after cleaning:
print(x_train_clean[0])
```

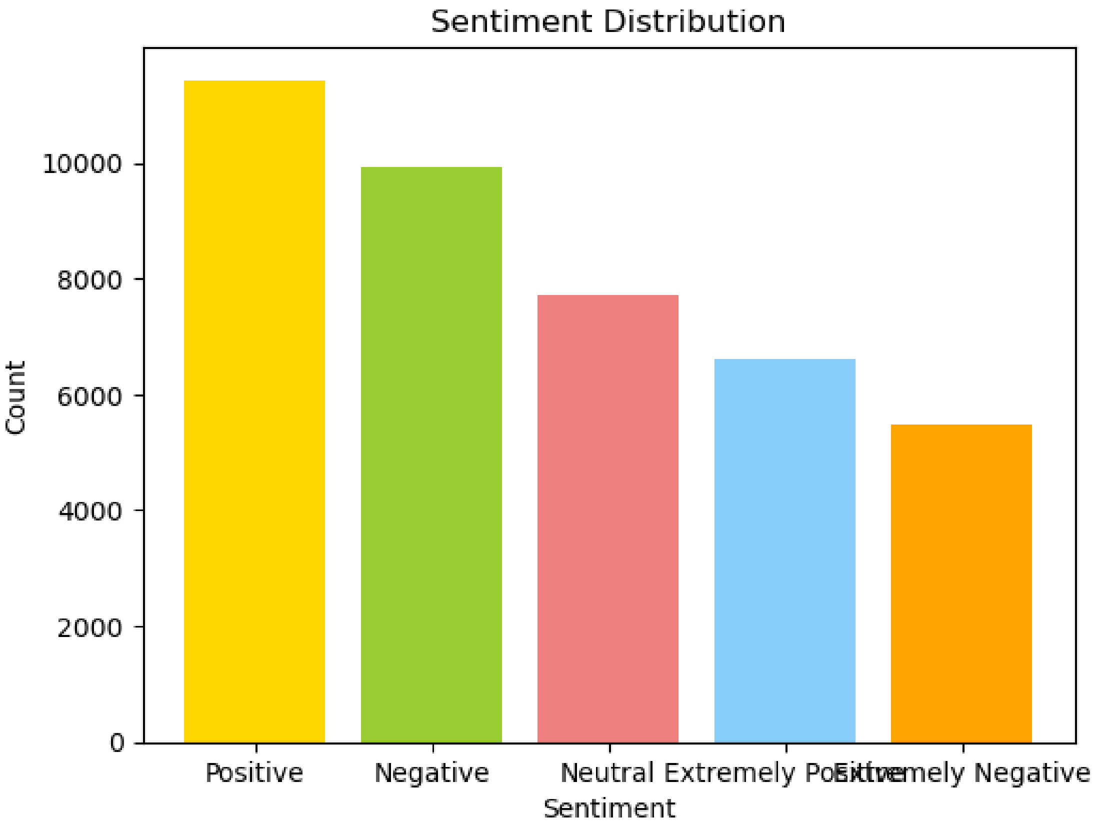
```
['unemployment', 'claim', 'made', 'online', 'virginia', 'week', 'monday',
'tuesday', 'number', 'going', 'get', 'bigger']
```

[55]:
```
# array of list (of clean text data)
x_train_clean
```

[55]:
```
array([list(['unemployment', 'claim', 'made', 'online', 'virginia', 'week',
'monday', 'tuesday', 'number', 'going', 'get', 'bigger']),
       list(['panicbuying', 'response', 'coronavirus', 'could', 'damaging',
'effect', 'agri', 'supply', 'chain', 'say', 'agri', 'economist', 'lunathi',
'hlakanyane', 'farmerschange', 'coronavirus', 'coronavirus']),
       list(['ecigarette', 'user', 'tobacco', 'smoker', 'danger', 'new',
'coronavirus', 'average', 'healthy', 'person']),
       …,
       list(['commented', 'poll', 'online', 'shopping', 'normal', 'coronavirus',
'crisis', '?']),
       list(['wife', 'got', 'laid', 'yesterday', 'small', 'retail', 'store',
'work', 'got', 'walloped', 'walkin', 'business', 'vanishing', 'coronavirus',
'long', 'thinking', 'taking', 'ei', 'process', 'claim', 'right', '?']),
       list(['humanity', 'doomed', 'coronavirus', 'coronavirus', 'toiletpaper',
'toiletpapier', 'coronavirus', 'coronavirus'])],
      dtype=object)
```

[56]:
```
sentiment_counts = train['Sentiment'].value_counts()
labels = ['Positive', 'Negative', 'Neutral', 'Extremely Positive', 'Extremely␣
 ↪Negative']
colors = ['gold', 'yellowgreen', 'lightcoral', 'lightskyblue', 'orange']

plt.bar(labels, sentiment_counts, color=colors)
plt.xlabel('Sentiment')
plt.ylabel('Count')
plt.title('Sentiment Distribution')
plt.show()
```



4 5. Text Preprocessing

4.1 Word Embedding and Sequence Padding

[57]:

```
max_len = max([len(sent) for sent in x_train_clean])
max_len
```

[57]:

```
151
```

4.1.1 Word Embedding

[58]:

```
from keras.preprocessing.text import Tokenizer

tok = Tokenizer(filters=None, oov_token='<OOV>')
tok.fit_on_texts(list(x_train_clean)+list(x_test_clean))

x_train_seq = tok.texts_to_sequences(x_train_clean)
x_test_seq = tok.texts_to_sequences(x_test_clean)
```

[59]:

```
# checking random data:
print(x_train_seq[0])
print(x_train_clean[0])
```

```
[815, 719, 220, 13, 3442, 39, 667, 1239, 273, 31, 18, 2630]
['unemployment', 'claim', 'made', 'online', 'virginia', 'week', 'monday',
'tuesday', 'number', 'going', 'get', 'bigger']
```

[60]:

```
# unique word tokens:
word_index = tok.word_index
len(word_index)
```

[60]:

```
42931
```

4.1.2 Sequence Padding

[61]:

```
from keras.utils import pad_sequences
x_train_pad = pad_sequences(x_train_seq, maxlen=max_len, padding='post')
x_test_pad = pad_sequences(x_test_seq, maxlen=max_len, padding='post')
```

[62]:

```
x_train_pad.shape, x_test_pad.shape
```

[62]:

```
((32925, 151), (8232, 151))
```

4.2 Label Encoding

[63]:

```
# before grouping:
print(np.unique(y_train))
print(np.unique(y_test))
```

```
['Extremely Negative' 'Extremely Positive' 'Negative' 'Neutral' 'Positive']
['Extremely Negative' 'Extremely Positive' 'Negative' 'Neutral' 'Positive']
```

[64]:

```
def encoder(data, enc=None):
  data[data=='Extremely Negative'] = 'Negative'
  data[data=='Extremely Positive'] = 'Positive'
  if(enc==None):
    from sklearn.preprocessing import OneHotEncoder
    onehot = OneHotEncoder()
    data_enc = onehot.fit_transform(np.array(data).reshape(-1,1)).toarray()
    return data_enc,onehot
  else:
    data_enc = enc.transform(np.array(data).reshape(-1,1)).toarray()
    return data_enc
```

[65]:

```
y_train_enc, enc = encoder(y_train)
y_test_enc = encoder(y_test,enc)
```

[66]:
```
y_train_enc, y_train_enc.shape
```

[66]:
```
(array([[1., 0., 0.],
        [1., 0., 0.],
        [1., 0., 0.],
        …,
        [1., 0., 0.],
        [0., 1., 0.],
        [1., 0., 0.]]),
 (32925, 3))
```

[67]:
```
y_test_enc, y_test_enc.shape
```

[67]:
```
(array([[0., 1., 0.],
        [1., 0., 0.],
        [0., 0., 1.],
        …,
        [1., 0., 0.],
        [0., 1., 0.],
        [1., 0., 0.]]),
 (8232, 3))
```

5 6. Neural Networks

[68]:
```
model = keras.Sequential([
    keras.layers.Embedding(len(word_index)+1, 151, input_length=max_len),
    keras.layers.SpatialDropout1D(0.5),
    keras.layers.Bidirectional(keras.layers.LSTM(100, recurrent_dropout=0.3)),
    keras.layers.BatchNormalization(),
    keras.layers.Dropout(0.6),
    keras.layers.Dense(1024, activation='relu'),
    keras.layers.BatchNormalization(),
    keras.layers.Dropout(0.6),

    keras.layers.Dense(3, activation='softmax')
])

model.compile(optimizer=keras.optimizers.Adam(learning_rate=0.001),
              loss='categorical_crossentropy', metrics=['accuracy'])
print(model.summary())
```

```
Model: "sequential"

_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 embedding (Embedding)       (None, 151, 151)          6482732
 spatial_dropout1d (SpatialD  (None, 151, 151)         0
 ropout1D)

 bidirectional (Bidirectiona  (None, 200)              201600
 l)

 batch_normalization (BatchN  (None, 200)              800
 ormalization)

 dropout (Dropout)           (None, 200)               0

 dense (Dense)               (None, 1024)              205824

 batch_normalization_1 (Batc  (None, 1024)             4096
 hNormalization)

 dropout_1 (Dropout)         (None, 1024)              0

 dense_1 (Dense)             (None, 3)                 3075

=================================================================
Total params: 6,898,127
Trainable params: 6,895,679
Non-trainable params: 2,448
_________________________________________________________________
None
```

5.1 Model Training

[70]:
```
es = keras.callbacks.EarlyStopping(monitor='val_loss', patience=10,␣
 ↪restore_best_weights=True, verbose=1)
reduce_lr = keras.callbacks.ReduceLROnPlateau(monitor='val_loss', patience=3,␣
 ↪verbose=1, factor=0.1)

logs = model.fit(x_train_pad,y_train_enc, validation_data=(x_test_pad,␣
 ↪y_test_enc),
                    epochs=20, batch_size=512, callbacks=[es, reduce_lr])
```

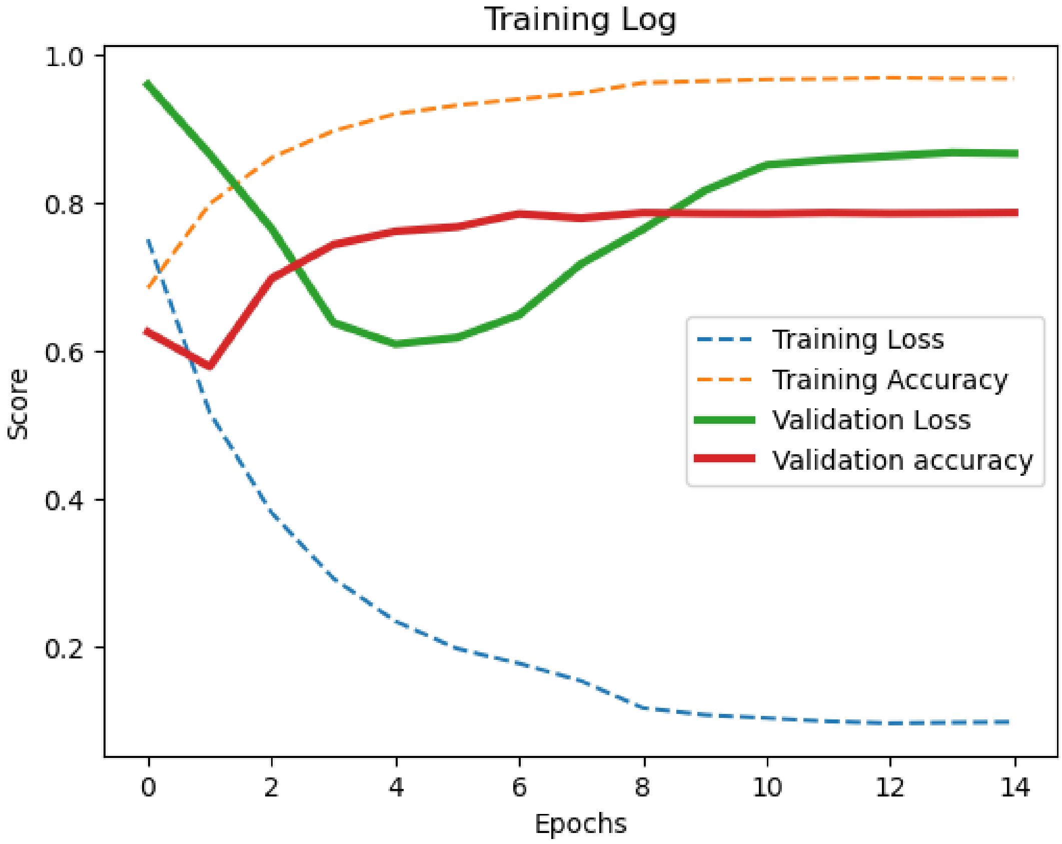
```
Epoch 1/20
65/65 [==============================] - 79s 1s/step - loss: 0.7508 - accuracy:
0.6851 - val_loss: 0.9599 - val_accuracy: 0.6259 - lr: 0.0010
Epoch 2/20
65/65 [==============================] - 77s 1s/step - loss: 0.5172 - accuracy:
0.7988 - val_loss: 0.8661 - val_accuracy: 0.5790 - lr: 0.0010
Epoch 3/20
65/65 [==============================] - 76s 1s/step - loss: 0.3817 - accuracy:
0.8613 - val_loss: 0.7655 - val_accuracy: 0.6981 - lr: 0.0010
```

```
Epoch 4/20
65/65 [==============================] - 73s 1s/step - loss: 0.2930 - accuracy:
0.8975 - val_loss: 0.6386 - val_accuracy: 0.7439 - lr: 0.0010
Epoch 5/20
65/65 [==============================] - 75s 1s/step - loss: 0.2352 - accuracy:
0.9206 - val_loss: 0.6094 - val_accuracy: 0.7617 - lr: 0.0010
Epoch 6/20
65/65 [==============================] - 74s 1s/step - loss: 0.1981 - accuracy:
0.9320 - val_loss: 0.6183 - val_accuracy: 0.7679 - lr: 0.0010
Epoch 7/20
65/65 [==============================] - 72s 1s/step - loss: 0.1782 - accuracy:
0.9405 - val_loss: 0.6490 - val_accuracy: 0.7856 - lr: 0.0010
Epoch 8/20
65/65 [==============================] - ETA: 0s - loss: 0.1547 - accuracy:
0.9486
Epoch 8: ReduceLROnPlateau reducing learning rate to 0.00010000000474974513.
65/65 [==============================] - 72s 1s/step - loss: 0.1547 - accuracy:
0.9486 - val_loss: 0.7178 - val_accuracy: 0.7796 - lr: 0.0010
Epoch 9/20
65/65 [==============================] - 71s 1s/step - loss: 0.1181 - accuracy:
0.9623 - val_loss: 0.7645 - val_accuracy: 0.7871 - lr: 1.0000e-04
Epoch 10/20
65/65 [==============================] - 71s 1s/step - loss: 0.1088 - accuracy:
0.9647 - val_loss: 0.8169 - val_accuracy: 0.7861 - lr: 1.0000e-04
Epoch 11/20
65/65 [==============================] - ETA: 0s - loss: 0.1044 - accuracy:
0.9670
Epoch 11: ReduceLROnPlateau reducing learning rate to 1.0000000474974514e-05.
65/65 [==============================] - 73s 1s/step - loss: 0.1044 - accuracy:
0.9670 - val_loss: 0.8516 - val_accuracy: 0.7858 - lr: 1.0000e-04
Epoch 12/20
65/65 [==============================] - 72s 1s/step - loss: 0.0999 - accuracy:
0.9679 - val_loss: 0.8584 - val_accuracy: 0.7871 - lr: 1.0000e-05
Epoch 13/20
65/65 [==============================] - 71s 1s/step - loss: 0.0973 - accuracy:
0.9694 - val_loss: 0.8634 - val_accuracy: 0.7862 - lr: 1.0000e-05
Epoch 14/20
65/65 [==============================] - ETA: 0s - loss: 0.0982 - accuracy:
0.9682
Epoch 14: ReduceLROnPlateau reducing learning rate to 1.0000000656873453e-06.
65/65 [==============================] - 73s 1s/step - loss: 0.0982 - accuracy:
0.9682 - val_loss: 0.8684 - val_accuracy: 0.7866 - lr: 1.0000e-05
Epoch 15/20
65/65 [==============================] - ETA: 0s - loss: 0.0990 - accuracy:
0.9683Restoring model weights from the end of the best epoch: 5.
65/65 [==============================] - 71s 1s/step - loss: 0.0990 - accuracy:
0.9683 - val_loss: 0.8670 - val_accuracy: 0.7872 - lr: 1.0000e-06
Epoch 15: early stopping
```

5.2 Training Graph

[71]:

```
import matplotlib.pyplot as plt
plt.title('Training Log')
plt.plot(logs.history['loss'], label='Training Loss', linestyle='dashed')
plt.plot(logs.history['accuracy'], label='Training Accuracy', linestyle='dashed')
plt.plot(logs.history['val_loss'], label='Validation Loss', linewidth=3)
plt.plot(logs.history['val_accuracy'], label='Validation accuracy', linewidth=3)
plt.xlabel('Epochs')
plt.ylabel('Score')
plt.legend()
plt.show()
```



[72]:

```
model.evaluate(x_test_pad,y_test_enc)
```

```
258/258 [==============================] - 19s 74ms/step - loss: 0.6094 -
accuracy: 0.7617
```

[72]:

```
[0.6093986630439758, 0.7616618275642395]
```

```
[73]: y_pred = model.predict(x_test_pad)
```

```
258/258 [==============================] - 21s 78ms/step
```

```
[74]: y_pred = enc.inverse_transform(y_pred)
      y_pred = np.squeeze(y_pred)
      y_pred
```

```
[74]: array(['Negative', 'Negative', 'Negative', …, 'Positive', 'Neutral',
             'Negative'], dtype=object)
```

```
[75]: res = pd.concat((y_test.reset_index(drop=True),pd.Series(y_pred)), axis=1,␣
        ↪keys=['actual','predicted'])
      res
```

```
[75]:         actual predicted
      0      Neutral  Negative
      1     Negative  Negative
      2     Positive  Negative
      3     Positive  Positive
      4     Negative  Negative
      …          …        …
      8227  Positive  Positive
      8228  Positive  Positive
      8229  Negative  Positive
      8230   Neutral   Neutral
      8231  Negative  Negative

       [8232 rows x 2 columns]
```

```
[76]: # instances of correct predictions:
      x = len(res.loc[res['actual']==res['predicted']])
      print(f"Correct Predictions: {x} out of {len(res)} instances")
```

```
Correct Predictions: 6270 out of 8232 instances
```

5.3 Testing

```
[77]: test_data = pd.read_csv('/kaggle/input/covid-19-nlp-text-classification/
        ↪Corona_NLP_test.csv', encoding='latin1')
      test_data
```

```
[77]:       UserName  ScreenName            Location     TweetAt  \
      0            1       44953                 NYC  02-03-2020
      1            2       44954         Seattle, WA  02-03-2020
      2            3       44955                 NaN  02-03-2020
      3            4       44956          Chicagoland  02-03-2020
```

```
4             5      44957  Melbourne, Victoria  03-03-2020
…          …          …                    …          …
3793       3794      48746            Israel ??  16-03-2020
3794       3795      48747       Farmington, NM  16-03-2020
3795       3796      48748        Haverford, PA  16-03-2020
3796       3797      48749                  NaN  16-03-2020
3797       3798      48750  Arlington, Virginia  16-03-2020

                                          OriginalTweet           Sentiment
0     TRENDING: New Yorkers encounter empty supermar…  Extremely Negative
1     When I couldn't find hand sanitizer at Fred Me…            Positive
2     Find out how you can protect yourself and love…  Extremely Positive
3     #Panic buying hits #NewYork City as anxious sh…            Negative
4     #toiletpaper #dunnypaper #coronavirus #coronav…             Neutral
…                                                   …                  …
3793  Meanwhile In A Supermarket in Israel -- People…            Positive
3794  Did you panic buy a lot of non-perishable item…            Negative
3795  Asst Prof of Economics @cconces was on @NBCPhi…             Neutral
3796  Gov need to do somethings instead of biar je r…  Extremely Negative
3797  I and @ForestandPaper members are committed to…  Extremely Positive

[3798 rows x 6 columns]
```

[78]:
```
test_data = create_data(test_data)
test_data
```

[78]:
```
                                                  texts              labels
0     TRENDING: New Yorkers encounter empty supermar…  Extremely Negative
1     When I couldn't find hand sanitizer at Fred Me…            Positive
2     Find out how you can protect yourself and love…  Extremely Positive
3     #Panic buying hits #NewYork City as anxious sh…            Negative
4     #toiletpaper #dunnypaper #coronavirus #coronav…             Neutral
…                                                   …                  …
3793  Meanwhile In A Supermarket in Israel -- People…            Positive
3794  Did you panic buy a lot of non-perishable item…            Negative
3795  Asst Prof of Economics @cconces was on @NBCPhi…             Neutral
3796  Gov need to do somethings instead of biar je r…  Extremely Negative
3797  I and @ForestandPaper members are committed to…  Extremely Positive

[3798 rows x 2 columns]
```

[79]:
```
test_overview=pd.concat([test_data.isnull().sum(),test_data.
 ↪nunique()],axis=1,keys=['Null Counts','Cardinality'])
test_overview
```

[79]:
```
        Null Counts  Cardinality
texts             0         3798
```

```
labels             0             5
```

```
[80]: import tqdm.notebook as tq
      test_data_clean = np.array([nlp(text) for text in tq.tqdm(test_data['texts'].
       ↪values, desc='Progress')], dtype='O')
```

```
Progress:   0%|          | 0/3798 [00:00<?, ?it/s]
```

```
[81]: test_data_clean
```

```
[81]: array([list(['trending', 'new', 'yorkers', 'encounter', 'empty', 'supermarket',
      'shelf', 'pictured', 'wegmans', 'brooklyn', 'soldout', 'online', 'grocer',
      'foodkick', 'maxdelivery', 'coronavirus', 'shopper', 'stock']),
             list(['could', 'find', 'hand', 'sanitizer', 'fred', 'meyer', 'turned',
      'amazon', 'pack', 'purell', '?', '?', '!', '!', 'check', 'coronavirus',
      'concern', 'driving', 'price']),
             list(['find', 'protect', 'loved', 'one', 'coronavirus', '?']), …,
             list(['asst', 'prof', 'economics', 'talking', 'recent', 'research',
      'coronavirus', 'impact', 'economy', 'watch', 'starting']),
             list(['gov', 'need', 'somethings', 'instead', 'biar', 'je', 'rakyat',
      'assume', 'lockdown', 'ke', 'even', 'worst', 'harini', 'semua', 'supermarket',
      'crowded', 'like', 'hell', 'lagi', 'mudah', 'virus', 'tu', 'tersebar', '?', '?',
      'coronavirus']),
             list(['member', 'committed', 'safety', 'employee', 'endusers',
      'monitoring', 'coronavirus', 'rest', 'assured', 'tissue', 'manufacturer',
      'continuing', 'produce', 'ship', 'product'])],
            dtype=object)
```

```
[82]: l = max([len(sent) for sent in test_data_clean])
      l
```

```
[82]: 40
```

```
[83]: test_data_seq = tok.texts_to_sequences(test_data_clean)
```

```
[84]: print(test_data_seq[0])
      print(test_data_clean[0])
```

```
[1910, 37, 4786, 5719, 144, 6, 51, 7143, 4495, 3107, 7016, 13, 1405, 1, 1, 2,
203, 28]
['trending', 'new', 'yorkers', 'encounter', 'empty', 'supermarket', 'shelf',
'pictured', 'wegmans', 'brooklyn', 'soldout', 'online', 'grocer', 'foodkick',
'maxdelivery', 'coronavirus', 'shopper', 'stock']
```

```
[85]: test_data_pad = pad_sequences(test_data_seq, maxlen=l, padding='post')
```

```
[86]: test_label_enc = encoder(test_data['labels'],enc)
      test_label_enc
```

```
[86]: array([[1., 0., 0.],
             [0., 0., 1.],
             [0., 0., 1.],
             …,
             [0., 1., 0.],
             [1., 0., 0.],
             [0., 0., 1.]])
```

```
[87]: model.evaluate(test_data_pad,test_label_enc)
```

```
119/119 [==============================] - 3s 22ms/step - loss: 0.6270 -
accuracy: 0.7428
```

```
[87]: [0.6269935369491577, 0.7427593469619751]
```

5.4 Testing our Model on Random Data

```
[88]: s1 = "Pandemic is very dangerous."
      s2 = "#tweet #danger Covid-19. Be safe."
      s3 = "I am going to buy a new mobile."
      s4 = "@Aniket, I love you."
      s5 = "Twitter is a greater platfrom to express"
      data=[]
      data.append(s1)
      data.append(s2)
      data.append(s3)
      data.append(s4)
      data.append(s5)

      data=pd.Series(data)
      data
```

```
[88]: 0                  Pandemic is very dangerous.
      1            #tweet #danger Covid-19. Be safe.
      2              I am going to buy a new mobile.
      3                         @Aniket, I love you.
      4     Twitter is a greater platfrom to express
      dtype: object
```

```
[89]: data_clean = np.array([nlp(text) for text in data.values], dtype='O')
      data_clean
```

```
[89]: array([list(['pandemic', 'dangerous']),
             list(['tweet', 'danger', 'coronavirus', 'safe']),
             list(['going', 'buy', 'new', 'mobile']), list(['love']),
             list(['twitter', 'greater', 'platfrom', 'express'])], dtype=object)
```

[90]:
```
mx_len = max([len(sent) for sent in data_clean])
data_seq = tok.texts_to_sequences(data_clean)
data_pad = pad_sequences(data_seq, maxlen=mx_len, padding='post')
```

[91]:
```
pred = model.predict(data_pad)
pred = enc.inverse_transform(pred)
```

```
1/1 [==============================] - 0s 437ms/step
```

[92]:
```
res = pd.concat((data,pd.Series(pred.ravel())), axis=1, keys=['texts',␣
 ↪'sentiments'])
res
```

[92]:
```
                                     texts sentiments
0                Pandemic is very dangerous.   Negative
1          #tweet #danger Covid-19. Be safe.   Positive
2            I am going to buy a new mobile.   Negative
3                        @Aniket, I love you.   Positive
4  Twitter is a greater platfrom to express   Positive
```