EE P 596: Advanced Introduction to Machine Learning

Project 3 Twitter Emotion Prediction

Predict the emotion of the given tweet.

Team Kaggle Name:

Students: Eric Chang & Naif Ganadily

Instructor - Prof. Karthik Mohan

TA - Ayush Singh

Grader - Fatwir SM

Final Due Date March 15th by 11:59pm

Part 1

Due March 12th by 11:59pm

Submit your solutions for parts 1, 2, 4 and 10 for this. You also need to make submissions to both the Kaggle competitions as a part of this submission. You can make updates on these submissions in the final submission as well.

Mini-Project Overview

In this mini-project, you have a dataset of English Twitter messages and would first have to learn and make predictions about the emotion in those tweets. There are 6 emotion labels present - anger, fear, joy, love, sadness, and surprise.

The data fields in the dataset are:

1. text: a string feature.

2. label: a classification label, with possible values including sadness (0), joy (1), love (2), anger (3), fear (4), surprise (5).

The first Kaggle competition requires you to make predictions on the labels given above.

The second Kaggle competition has similar string and a set of possible emotions stored as a list. You can use your previous model trained for the first kaggle competition as a starting point for the second task. Zero-shot setting refers to emotions the model hasn't seen before and make predictions on it. E.g. "Morose". You would have to have the model pick from one of the input emotions amongst it.

Submission Guidelines

* You get to work in teams of 2 for the Kaggle and modeling piece!! Please make sure each person of the team gets to work on all aspects of the mini-project and mention at the top of your report the contributions from each person.

* The submission is in 2 parts.

* Code: Please submit a Jupyter/IPython notebook file, report and Kaggle predictions as part of your submission. You can start with the template notebook provided and add in your solutions to it.

* Report: The report should be in a pdf format and have plots, correlation matrices and tables added in as mentioned in the Heart Rate Deliverables below. Feel free to use either latex or word for creating it. Include answers to conceptual questions, and your insights as well. Ideally you should NOT use comments in ipynb to answer any conceptual question.

* Kaggle Contest: There are a couple of Kaggle competitions, where you submit predictions on "held out" data sets.

Dataset Description

##Files

* Local dataset can be found on Canvas.

* Kaggle1 Dataset - the test set

* sample_submission.csv - a sample submission file in the correct format

##Columns of submission

* index - a list from 0 to 2000, corresponding to the index in the kaggle text dataset.

* labels - predicted labels for the given index rows.

Twitter Emotion Deliverables

1. Basics and Visualization: Load the local dataset. Briefly explain the format in which the dataset is stored. Show the number of data points for each emotion in the test data set. (20 points)

2. Logistic Regression: Tokenize the given sentences. You can use any library for tokenization. Then use a Logistic Regression model for prediction. (30 points)

3. LSTM: Use a LSTM model for the given prediction task. (40 points)

4. Transformer-based: Use a Transformer-based model for the task of fine-tuning on the emotions data set. Briefly explain why you chose the given architecture and how was the model pre-trained (if it was)? You can get started with Hugging Face models for this - An example notebook is already part of the lecture materials (huggingface.co) (40 points)

5. Insights: What insights did you gain by working on this data set? What are the pros/cons of each ML model? Describe your thought process as well in the choices you made as you set up the machine learning pipeline. Also mention how you took care of over-fitting if any. (15 points)

6. Tabular Results: Compare the 3 models earlier in a tabular format (table) on the standard metrics for classification - f1-score, precision, recall. (5 points)

7. Scalability: If you had to scale your model to a million training data points, which of the models would you pick, what bottlenecks would you face and present a rough idea on how you would scale? (10 points)

8. Plot the curves of training, validation and test sets losses and accuracy scores with number of epochs on the x-axis for the model which gave the best metrics. Show a table in which rows are the algorithms/models used and having Precision, Recall and F1-score as metrics. (15 points)

9. Interpretability - Print/plot examples of tweets that were misclassified by your best model (False positives and also False negatives). Are the given labels correct? Why do you think the model might have done a mis-classification here? (10 points)

10. As mentioned in the overview, for the second Kaggle competition, come up with an algorithm to make predictions on it. (HINT: You might want to use word similarity models to find similar emotions to the predicted one.) Clearly describe your approach in the writeup. (40 points)

11. Kaggle submission (1st - 5 points + 2nd - 10 points)
   1.   [√√]

2. [✓✓]
3. [✓✓]
4. [✓✓]
5. [-]
6. [-]
7. [-]
8. [-]
9. [-]
10. [-]
11. [-]

Loading the Libararies

```
# Import the required libraries

!pip install transformers
!pip install accelerate
```

```
Looking in indexes: https://pypi.org/simple, https://us-
python.pkg.dev/colab-wheels/public/simple/
Collecting transformers
  Downloading transformers-4.26.1-py3-none-any.whl (6.3 MB)
━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 6.3/6.3 MB 51.8 MB/s eta
0:00:00
ent already satisfied: numpy>=1.17 in /usr/local/lib/python3.9/dist-
packages (from transformers) (1.24.2)
Requirement already satisfied: filelock in
/usr/local/lib/python3.9/dist-packages (from transformers) (3.9.0)
Requirement already satisfied: requests in
/usr/local/lib/python3.9/dist-packages (from transformers) (2.25.1)
Collecting tokenizers!=0.11.3,<0.14,>=0.11.1
  Downloading tokenizers-0.13.2-cp39-cp39-
manylinux_2_17_x86_64.manylinux2014_x86_64.whl (7.6 MB)
━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 7.6/7.6 MB 87.5 MB/s eta
0:00:00
ent already satisfied: packaging>=20.0 in
/usr/local/lib/python3.9/dist-packages (from transformers) (23.0)
Requirement already satisfied: tqdm>=4.27 in
/usr/local/lib/python3.9/dist-packages (from transformers) (4.65.0)
Requirement already satisfied: pyyaml>=5.1 in
/usr/local/lib/python3.9/dist-packages (from transformers) (6.0)
Collecting huggingface-hub<1.0,>=0.11.0
  Downloading huggingface_hub-0.13.2-py3-none-any.whl (199 kB)
━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 199.2/199.2 KB 19.7 MB/s
0:00:00
ent already satisfied: regex!=2019.12.17 in
/usr/local/lib/python3.9/dist-packages (from transformers) (2022.6.2)
Requirement already satisfied: typing-extensions>=3.7.4.3 in
```

```
/usr/local/lib/python3.9/dist-packages (from huggingface-
hub<1.0,>=0.11.0->transformers) (4.5.0)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in
/usr/local/lib/python3.9/dist-packages (from requests->transformers)
(1.26.15)
Requirement already satisfied: idna<3,>=2.5 in
/usr/local/lib/python3.9/dist-packages (from requests->transformers)
(2.10)
Requirement already satisfied: chardet<5,>=3.0.2 in
/usr/local/lib/python3.9/dist-packages (from requests->transformers)
(4.0.0)
Requirement already satisfied: certifi>=2017.4.17 in
/usr/local/lib/python3.9/dist-packages (from requests->transformers)
(2022.12.7)
Installing collected packages: tokenizers, huggingface-hub,
transformers
Successfully installed huggingface-hub-0.13.2 tokenizers-0.13.2
transformers-4.26.1
Looking in indexes: https://pypi.org/simple, https://us-
python.pkg.dev/colab-wheels/public/simple/
Collecting accelerate
  Downloading accelerate-0.17.1-py3-none-any.whl (212 kB)
━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 212.8/212.8 KB 6.3 MB/s eta
0:00:00
ent already satisfied: torch>=1.4.0 in /usr/local/lib/python3.9/dist-
packages (from accelerate) (1.13.1+cu116)
Requirement already satisfied: psutil in
/usr/local/lib/python3.9/dist-packages (from accelerate) (5.4.8)
Requirement already satisfied: packaging>=20.0 in
/usr/local/lib/python3.9/dist-packages (from accelerate) (23.0)
Requirement already satisfied: pyyaml in
/usr/local/lib/python3.9/dist-packages (from accelerate) (6.0)
Requirement already satisfied: numpy>=1.17 in
/usr/local/lib/python3.9/dist-packages (from accelerate) (1.24.2)
Requirement already satisfied: typing-extensions in
/usr/local/lib/python3.9/dist-packages (from torch>=1.4.0->accelerate)
(4.5.0)
Installing collected packages: accelerate
Successfully installed accelerate-0.17.1
```

```python
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt

import numpy as np
import pandas as pd

from sklearn.model_selection import train_test_split

# Added Libraries
```

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

from sklearn.feature_extraction.text import CountVectorizer

from sklearn.linear_model import LogisticRegression
from sklearn.ensemble import RandomForestClassifier
from sklearn.model_selection import GridSearchCV

from sklearn.metrics import classification_report, confusion_matrix,
accuracy_score, ConfusionMatrixDisplay

nltk.download('omw-1.4')
from nltk.corpus import stopwords
from nltk.tokenize import word_tokenize
nltk.download('stopwords')
nltk.download('punkt')
```

```
[nltk_data] Downloading package omw-1.4 to /root/nltk_data...
[nltk_data] Downloading package stopwords to /root/nltk_data...
[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!

True
```

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

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

Exercise 1

```
# Loading the dataset
def data_loader(file_path):

  df = pd.read_csv(file_path)

  return display(df), display(df.shape)
```

Applying the data_loader to all the datasets:
```
# Using the data_loader function to show the dataset and shape
# Test Dataset 1
print('Training Dataset:')
data_loader('/content/Kaggle1_Dataset.csv')
print()
print('Training Dataset 1 & Test Dataset 1 Submission Example:')
data_loader('/content/kaggle1_sample_submission.csv')
print()
```

```
print('Test Dataset 2:')
# Using the data_loader function to show the dataset and shape
# Test Dataset 2 ?
# Based on this dataset maybe BERT or RoBERTa or EmoReact or EmoBERT?
data_loader('/content/Kaggle2_Dataset.csv')
print()
print('Training Dataset 1 & Test Dataset 2 Submission Example:')
# Using the data_loader function to show the dataset and shape
# Submission and Solutions Example
# Based on this dataset maybe BERT or RoBERTa or EmoReact or EmoBERT?
data_loader('/content/kaggle2_sample_solutions.csv')
```

Training Dataset:

```
        index                                               text
0           0  im feeling quite sad and sorry for myself but ...
1           1  i feel like i am still looking at a blank canv...
2           2                          i feel like a faithful servant
3           3                      i am just feeling cranky and blue
4           4  i can have for a treat or if i am feeling festive
...       ...                                                ...
1995     1995  im having ssa examination tomorrow in the morn...
1996     1996  i constantly worry about their fight against n...
1997     1997  i feel its important to share this info for th...
1998     1998  i truly feel that if you are passionate enough...
1999     1999  i feel like i just wanna buy any cute make up ...

[2000 rows x 2 columns]

(2000, 2)
```

Training Dataset 1 & Test Dataset 1 Submission Example:

```
        index  labels
0           0       0
1           1       0
2           2       0
3           3       0
4           4       0
...       ...     ...
1995     1995       0
1996     1996       0
1997     1997       0
1998     1998       0
1999     1999       0

[2000 rows x 2 columns]

(2000, 2)
```

Test Dataset 2:

```
       index                                               text  \
0          0  im feeling rather rotten so im not very ambiti...
1          1            im updating my blog because i feel shitty
2          2  i never make her separate from me because i do...
3          3  i left with my bouquet of red and yellow tulip...
4          4    i was feeling a little vain when i did this one
...      ...                                                ...
1995    1995  i just keep feeling like someone is being unki...
1996    1996  im feeling a little cranky negative after this...
1997    1997  i feel that i am useful to my people and that ...
1998    1998  im feeling more comfortable with derby i feel ...
1999    1999  i feel all weird when i have to meet w people ...


                                      possible_emotions
0        ['alarm', 'exasperation', 'terror', 'tendernes...
1        ['shock', 'jubilation', 'shock', 'fright', 'fr...
2        ['panic', 'shock', 'exultation', 'fright', 'jo...
3        ['attachment', 'annoyance', 'exasperation', 'i...
4        ['tenderness', 'tenderness', 'exultation', 'tr...
...                                                  ...
1995     ['jubilation', 'fondness', 'depression', 'stag...
1996     ['alarm', 'warmth', 'tenderness', 'depression'...
1997     ['sorrow', 'fright', 'intimacy', 'stun', 'depr...
1998     ['depression', 'stun', 'warmth', 'annoyance', ...
1999     ['shock', 'vexation', 'warmth', 'unhappiness',...

[2000 rows x 3 columns]

(2000, 3)
```

Training Dataset 1 & Test Dataset 2 Submission Example:

```
       index  labels
0          0  regret
1          1  regret
2          2  regret
3          3  regret
4          4  regret
...      ...     ...
1995    1995  regret
1996    1996  regret
1997    1997  regret
1998    1998  regret
1999    1999  regret

[2000 rows x 2 columns]
```

```
(2000, 2)

(None, None)
```

As we can see, the dataset has two columns: a text column and a label column. The text column contains a collection of tweets, and the label column contains integers ranging from 0 to 5, where each integer represents an emotion. sadness (0), joy (1), love (2), anger (3), fear (4), surprise (5).

```python
import pandas as pd

def visualize(df):
    df = pd.read_csv(df)
    print(df.columns)
    emotions = df['label'].value_counts()
    # Counting every data point and saving it as a series

    emotions.plot(kind='bar')
    plt.title('Showcasing the Data Points for Each Emotion')
    plt.xlabel('Emotion')
    plt.ylabel('Number of Data Points')

    # Assigning each data point to its corresponding Label
    dict_labels = {0: 'Sadness', 1: 'Joy', 2: 'Love', 3: 'Anger', 4:
'Fear', 5: 'Surprise'}
    plt.xticks(emotions.index, emotions.index.map(dict_labels),
rotation=0)
    label_counts = {dict_labels[k]: v for k, v in emotions.items()}
    plt.show()

    return label_counts

df = '/content/Local_Dataset.csv'
visualize(df)

Index(['text', 'label'], dtype='object')
```

Showcasing the Data Points for Each Emotion
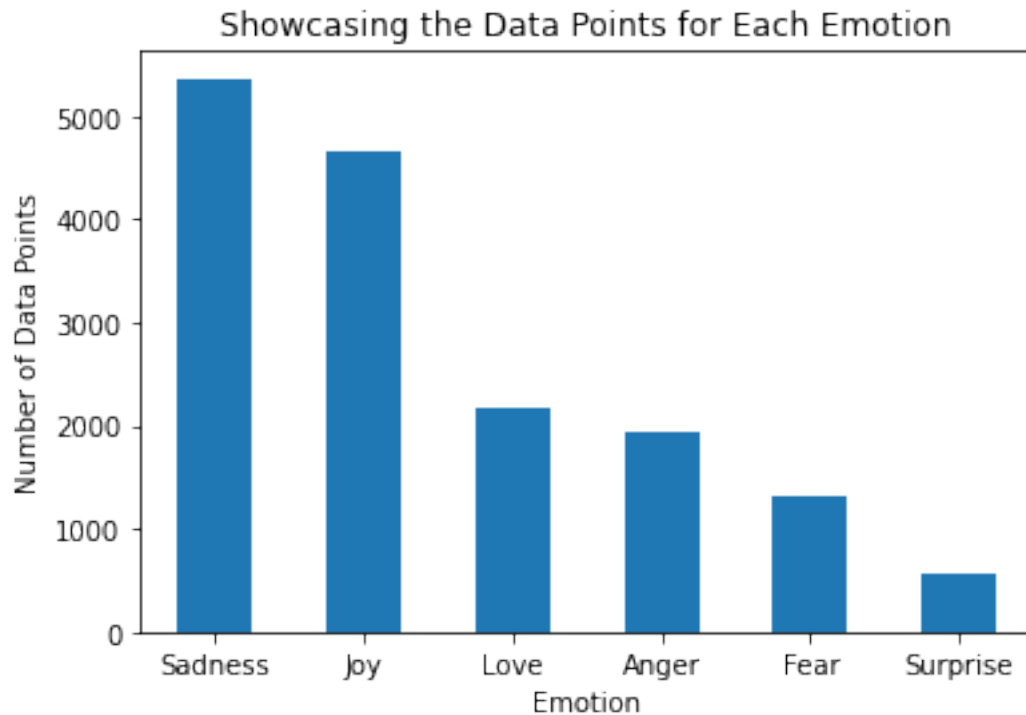

```
{'Joy': 5362,
 'Sadness': 4666,
 'Anger': 2159,
 'Fear': 1937,
 'Love': 1304,
 'Surprise': 572}

df = pd.read_csv(df)
df['label'].value_counts()

1    5362
0    4666
3    2159
4    1937
2    1304
5     572
Name: label, dtype: int64
```

Exercise 2

```
df =
pd.read_csv('/content/drive/MyDrive/Intro2AdvancedML/TwitterSentimentP
roject/TwitterSentiment.csv')
df.dtypes

text     object
label     int64
dtype: object
```

Logistic Regression and Vetroization with limited Metrics and no iterational limit without Preprocessing

Accuracy: 0.8815625

```python
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.metrics import accuracy_score, classification_report,
confusion_matrix, precision_score, recall_score, f1_score,
roc_auc_score


def tokenize(df):
    # CountVectorizer object to tokenize the tweets
    # from the 'text' column
    # fitting it to the 'text' column
    cv = CountVectorizer()
    df = pd.read_csv('/content/Local_Dataset.csv')
    # Converting the 'text' from object to string
    df['text'] = df['text'].astype(str)
    cv.fit(df['text'])

    tokenized = cv.transform(df['text'])

    # Return a list of tokenized tweets.
    return tokenized


# Tokenize the tweets
tokenized_df = tokenize(df)


def LR(df):
    X = tokenize(df)
    y = df['label']

    X_train, X_test, y_train, y_test = train_test_split(X, y,
test_size=0.2, random_state=42)
    lr = LogisticRegression()
    lr.fit(X_train, y_train)

    y_pred = lr.predict(X_test)
    accuracy = accuracy_score(y_test, y_pred)
    print('Accuracy:', accuracy)
    print(classification_report(y_test, y_pred))
    print()
    print('Confusion Matrix: \n')
    cf_matrix = confusion_matrix(y_test, y_pred)
    cm_display = ConfusionMatrixDisplay(confusion_matrix=cf_matrix,
display_labels = ['Sadness', 'Joy', 'Love', 'Anger', 'Fear',
```

```
                                                     'Surprise'])
    cm_display.plot()
    plt.show()

    print()
    print('Accuracy: ', accuracy_score(y_test, y_pred))

    # For the Tabular Table
    return y_pred, y_test

y_pred, y_test = LR(df)
```

/usr/local/lib/python3.9/dist-packages/sklearn/linear_model/
_logistic.py:458: ConvergenceWarning: lbfgs failed to converge
(status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as
shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:

https://scikit-learn.org/stable/modules/linear_model.html#logistic-
regression
  n_iter_i = _check_optimize_result(

Accuracy: 0.8815625

	precision	recall	f1-score	support
0	0.92	0.93	0.92	946
1	0.88	0.93	0.90	1021
2	0.81	0.74	0.77	296
3	0.90	0.86	0.88	427
4	0.84	0.83	0.83	397
5	0.82	0.67	0.74	113
accuracy			0.88	3200
macro avg	0.86	0.83	0.84	3200
weighted avg	0.88	0.88	0.88	3200

Confusion Matrix:

Accuracy: 0.8815625

Logistic Regression and Vetroization with limited Metrics and no iterational limit with Preprocessing

Accuracy: 0.8921875

```
!pip uninstall nltk
!pip install nltk
import nltk
nltk.download('omw-1.4')
```

```
Found existing installation: nltk 3.7
Uninstalling nltk-3.7:
  Would remove:
    /usr/local/bin/nltk
    /usr/local/lib/python3.9/dist-packages/nltk-3.7.dist-info/*
    /usr/local/lib/python3.9/dist-packages/nltk/*
Proceed (Y/n)? Y
  Successfully uninstalled nltk-3.7
Looking in indexes: https://pypi.org/simple, https://us-
python.pkg.dev/colab-wheels/public/simple/
Collecting nltk
  Downloading nltk-3.8.1-py3-none-any.whl (1.5 MB)
━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 1.5/1.5 MB 21.1 MB/s eta
0:00:00
ent already satisfied: regex>=2021.8.3 in
/usr/local/lib/python3.9/dist-packages (from nltk) (2022.6.2)
Requirement already satisfied: tqdm in /usr/local/lib/python3.9/dist-
```

```
packages (from nltk) (4.65.0)
Requirement already satisfied: click in /usr/local/lib/python3.9/dist-
packages (from nltk) (8.1.3)
Requirement already satisfied: joblib in
/usr/local/lib/python3.9/dist-packages (from nltk) (1.1.1)
Installing collected packages: nltk
Successfully installed nltk-3.8.1
```

{"pip_warning":{"packages":["nltk"]}}

```
[nltk_data] Downloading package omw-1.4 to /root/nltk_data...
```

True

```python
import pandas as pd
import nltk
from nltk.stem import WordNetLemmatizer
from nltk.corpus import stopwords
from nltk.stem import WordNetLemmatizer
import string

nltk.download('stopwords')
nltk.download('wordnet')

# Defining stopwords and lemmatizer
stopwords = set(stopwords.words('english'))
lemmatizer = WordNetLemmatizer()


def text_processing(text):


    #Convert to lowercase
    #Remove punctuation
    #Tokenize the text
    #Remove stopwords
    #Lemmatize the tokens


    text = text.lower()

    text = text.translate(str.maketrans('', '', string.punctuation))

    tokens = text.split()

    tokens = [token for token in tokens if token not in stopwords]

    tokens = [lemmatizer.lemmatize(token) for token in tokens]
    text = ' '.join(tokens)
    return text
```

```python
df['text'] = df['text'].apply(text_processing)

# Define function to tokenize tweets
def tokenize(df):
    # CountVectorizer object to tokenize the tweets
    # from the 'text' column
    # fitting it to the 'text' column
    cv = CountVectorizer()
    # Converting the 'text' from object to string
    df['text'] = df['text'].astype(str)
    cv.fit(df['text'])

    tokenized = cv.transform(df['text'])

    # Return a list of tokenized tweets.
    return tokenized

# Define function to train logistic regression model
def LR(df):
    X = tokenize(df)
    y = df['label']

    X_train, X_test, y_train, y_test = train_test_split(X, y,
test_size=0.2, random_state=42)
    lr = LogisticRegression()
    lr.fit(X_train, y_train)

    y_pred = lr.predict(X_test)
    accuracy = accuracy_score(y_test, y_pred)
    print('Accuracy:', accuracy)
    print(classification_report(y_test, y_pred))
    print()
    print('Confusion Matrix: \n')
    cf_matrix = confusion_matrix(y_test, y_pred)
    cm_display = ConfusionMatrixDisplay(confusion_matrix=cf_matrix,
display_labels = ['Sadness', 'Joy', 'Love', 'Anger', 'Fear',
'Surprise'])
    cm_display.plot()
    plt.show()

    print()
    print('Accuracy: ', accuracy_score(y_test, y_pred))

    # For the Tabular Table
    return y_pred, y_test

# Train and evaluate the logistic regression model
LR(df)
```

Accuracy: 0.8921875
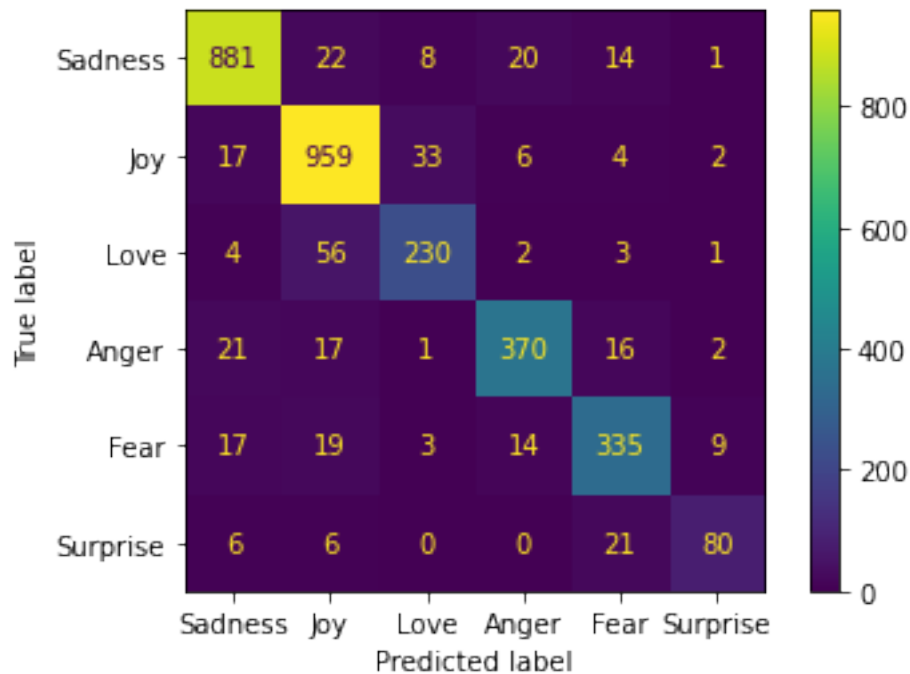```
              precision   recall f1-score   support

           0   0.93   0.93   0.93   946
           1   0.89   0.94   0.91   1021
           2   0.84   0.78   0.81   296
           3   0.90   0.87   0.88   427
           4   0.85   0.84   0.85   397
           5   0.84   0.71   0.77   113

    accuracy   0.89   3200
   macro avg   0.87   0.84   0.86   3200
weighted avg   0.89   0.89   0.89   3200
```

Confusion Matrix:

```
Accuracy:  0.8921875

(array([0, 1, 0, ..., 1, 1, 0]), 8756      0
 4660      1
 6095      0
 304       1
 8241      0
           ..
 15578     1
 5746      1
 6395      1
 7624      1
 15245     0
Name: label, Length: 3200, dtype: int64)
```

Logistic Regression and tokenization with a limit on iterations and Macro Metrics without Preprocessing

Accuracy: 0.8815625
```python
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.metrics import accuracy_score, classification_report,
confusion_matrix, precision_score, recall_score, f1_score,
roc_auc_score
from sklearn.metrics import precision_recall_curve

def tokenize(df):
```

```python
        # CountVectorizer object to tokenize the tweets
        # from the 'text' column
        # fitting it to the 'text' column
        cv = CountVectorizer()
        # Converting the 'text' from object to string
        df['text'] = df['text'].astype(str)
        cv.fit(df['text'])

        tokenized = cv.transform(df['text'])

        # Return a list of tokenized tweets.
        return tokenized


# Tokenize the tweets
df = pd.read_csv('/content/Local_Dataset.csv')
test_df = pd.read_csv('/content/Kaggle1_Dataset.csv')

tokenized_df = tokenize(df)

# To test the model on a tokenized test dataset
tokenized_kaggle = tokenize(test_df)

#
https://scikit-learn.org/stable/modules/generated/sklearn.preprocessin
g.LabelBinarizer.html
from sklearn.preprocessing import LabelBinarizer

def LR(df, max_iter=2000):
    X = tokenized_df
    y = df['label']
#-------------------------------------------------------------------
----#
# Train Test Split using the fitting with Logistic Regression
    X_train, X_test, y_train, y_test = train_test_split(X, y,
test_size=0.2, random_state=42)
    lr = LogisticRegression()
    lr.fit(X_train, y_train)
#-------------------------------------------------------------------
----#
    y_pred = lr.predict(X_test)
    lb = LabelBinarizer()
    lb.fit(y_test)
    test_labels = lb.transform(y_test)
    test_predictions = lb.transform(y_pred)
#-------------------------------------------------------------------
----#
    accuracy = accuracy_score(y_test, y_pred)
    precision_macro = precision_score(y_test, y_pred, average='macro')
```

```python
    recall_macro = recall_score(y_test, y_pred, average='macro')
    f1_macro = f1_score(y_test, y_pred, average='macro')
    auc_macro = roc_auc_score(test_labels, test_predictions,
average='macro', multi_class='ovo')
#--------------------------------------------------------------------
----#
    print('Accuracy:', accuracy)
    print(classification_report(y_test, y_pred))
    print()
    print('Confusion Matrix: \n')
    cf_matrix = confusion_matrix(y_test, y_pred)
    cm_display = ConfusionMatrixDisplay(confusion_matrix=cf_matrix,
display_labels = ['Sadness', 'Joy', 'Love', 'Anger', 'Fear',
'Surprise'])
    cm_display.plot()
    plt.show()

    print()
    print('Macro Precision:', precision_macro)
    print('Macro Recall:', recall_macro)
    print('Macro F1-score:', f1_macro)
    print('Macro AUC:', auc_macro)


LR(df, max_iter=2000)
```

```
/usr/local/lib/python3.9/dist-packages/sklearn/linear_model/
_logistic.py:458: ConvergenceWarning: lbfgs failed to converge
(status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as
shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:

https://scikit-learn.org/stable/modules/linear_model.html#logistic-
regression
  n_iter_i = _check_optimize_result(

Accuracy: 0.8815625
```

	precision	recall	f1-score	support
0	0.92	0.93	0.92	946
1	0.88	0.93	0.90	1021
2	0.81	0.74	0.77	296
3	0.90	0.86	0.88	427
4	0.84	0.83	0.83	397
5	0.82	0.67	0.74	113

```
       accuracy                          0.88         3200
      macro avg        0.86        0.83   0.84         3200
   weighted avg        0.88        0.88   0.88         3200
```

Confusion Matrix:


```
Macro Precision: 0.8614304963046783
Macro Recall: 0.826633373173518
Macro F1-score: 0.8423217917067366
Macro AUC: 0.9004557117676595
```

Logistic Regression and tokenization with a limit on iterations and Macro Metrics with Preprocessing

Accuracy: 0.8915625
```
!pip uninstall nltk
!pip install nltk
import nltk
nltk.download('omw-1.4')

Found existing installation: nltk 3.8.1
Uninstalling nltk-3.8.1:
  Would remove:
    /usr/local/bin/nltk
    /usr/local/lib/python3.9/dist-packages/nltk-3.8.1.dist-info/*
    /usr/local/lib/python3.9/dist-packages/nltk/*
```

```
Proceed (Y/n)? Y
  Successfully uninstalled nltk-3.8.1
Looking in indexes: https://pypi.org/simple, https://us-
python.pkg.dev/colab-wheels/public/simple/
Collecting nltk
  Using cached nltk-3.8.1-py3-none-any.whl (1.5 MB)
Requirement already satisfied: joblib in
/usr/local/lib/python3.9/dist-packages (from nltk) (1.1.1)
Requirement already satisfied: regex>=2021.8.3 in
/usr/local/lib/python3.9/dist-packages (from nltk) (2022.6.2)
Requirement already satisfied: tqdm in /usr/local/lib/python3.9/dist-
packages (from nltk) (4.65.0)
Requirement already satisfied: click in /usr/local/lib/python3.9/dist-
packages (from nltk) (8.1.3)
Installing collected packages: nltk
Successfully installed nltk-3.8.1

{"pip_warning":{"packages":["nltk"]}}

[nltk_data] Downloading package omw-1.4 to /root/nltk_data...
[nltk_data]   Package omw-1.4 is already up-to-date!

True
```

```python
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.metrics import accuracy_score, classification_report,
confusion_matrix, precision_score, recall_score, f1_score,
roc_auc_score
from sklearn.metrics import precision_recall_curve


import pandas as pd
import nltk
from nltk.stem import WordNetLemmatizer
from nltk.corpus import stopwords
from nltk.stem import WordNetLemmatizer
import string

nltk.download('stopwords')
nltk.download('wordnet')

# Defining stopwords and lemmatizer
stopwords = set(stopwords.words('english'))
lemmatizer = WordNetLemmatizer()


def text_processing(text):
```

```python
    #Convert to lowercase
    #Remove punctuation
    #Tokenize the text
    #Remove stopwords
    #Lemmatize the tokens


    text = text.lower()

    text = text.translate(str.maketrans('', '', string.punctuation))

    tokens = text.split()

    tokens = [token for token in tokens if token not in stopwords]

    tokens = [lemmatizer.lemmatize(token) for token in tokens]
    text = ' '.join(tokens)
    return text

df = pd.read_csv('/content/Local_Dataset.csv')
df['text'] = df['text'].apply(text_processing)

def tokenize(df):
    # CountVectorizer object to tokenize the tweets
    # from the 'text' column
    # fitting it to the 'text' column
    cv = CountVectorizer()
    # Converting the 'text' from object to string
    df['text'] = df['text'].astype(str)
    cv.fit(df['text'])

    tokenized = cv.transform(df['text'])

    # Return a list of tokenized tweets.
    return tokenized

# Tokenize and Preprocess the tweets
tokenized_df = tokenize(df)

# To test the model on a tokenized test dataset
test_df = pd.read_csv('/content/Kaggle1_Dataset.csv')
test_df['text'] = test_df['text'].apply(text_processing)
tokenized_kaggle = tokenize(test_df)

#
https://scikit-learn.org/stable/modules/generated/sklearn.preprocessin
g.LabelBinarizer.html
from sklearn.preprocessing import LabelBinarizer
```

```python
def LR(df, max_iter=2000):
    X = tokenized_df
    y = df['label']
    #-------------------------------------------------------------------
----#
    # Train Test Split using the fitting with Logistic Regression
    X_train, X_test, y_train, y_test = train_test_split(X, y,
test_size=0.2, random_state=42)
    lr = LogisticRegression()
    lr.fit(X_train, y_train)
    #-------------------------------------------------------------------
----#
    y_pred = lr.predict(X_test)
    lb = LabelBinarizer()
    lb.fit(y_test)
    test_labels = lb.transform(y_test)
    test_predictions = lb.transform(y_pred)
    #-------------------------------------------------------------------
----#
    accuracy = accuracy_score(y_test, y_pred)
    precision_macro = precision_score(y_test, y_pred, average='macro')
    recall_macro = recall_score(y_test, y_pred, average='macro')
    f1_macro = f1_score(y_test, y_pred, average='macro')
    auc_macro = roc_auc_score(test_labels, test_predictions,
average='macro', multi_class='ovo')
    #-------------------------------------------------------------------
----#
    print('Accuracy:', accuracy)
    print(classification_report(y_test, y_pred))
    print()
    print('Confusion Matrix: \n')
    cf_matrix = confusion_matrix(y_test, y_pred)
    cm_display = ConfusionMatrixDisplay(confusion_matrix=cf_matrix,
display_labels = ['Sadness', 'Joy', 'Love', 'Anger', 'Fear',
'Surprise'])
    cm_display.plot()
    plt.show()

    print()
    print('Macro Precision:', precision_macro)
    print('Macro Recall:', recall_macro)
    print('Macro F1-score:', f1_macro)
    print('Macro AUC:', auc_macro)


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

```
LR(df, max_iter=2000)
```

```
/usr/local/lib/python3.9/dist-packages/sklearn/linear_model/
_logistic.py:458: ConvergenceWarning: lbfgs failed to converge
(status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as
shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:

https://scikit-learn.org/stable/modules/linear_model.html#logistic-
regression
  n_iter_i = _check_optimize_result(

Accuracy: 0.8915625
              precision    recall  f1-score   support

           0       0.93      0.93      0.93       946
           1       0.89      0.94      0.91      1021
           2       0.84      0.77      0.80       296
           3       0.90      0.87      0.88       427
           4       0.85      0.84      0.85       397
           5       0.84      0.71      0.77       113

    accuracy                           0.89      3200
   macro avg       0.87      0.84      0.86      3200
weighted avg       0.89      0.89      0.89      3200


Confusion Matrix:
```
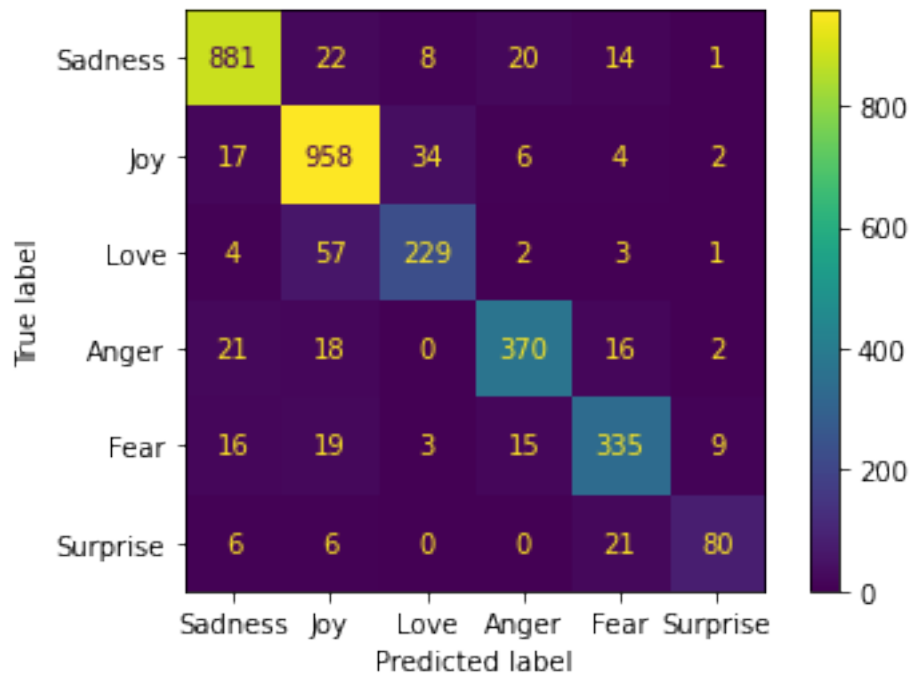
```
Macro Precision: 0.87424748931107
Macro Recall: 0.8435896555766926
Macro F1-score: 0.8575870009744162
Macro AUC: 0.9100501033399157
```

A Article on Macro and Micro Metrics

https://medium.com/@ramit.singh.pahwa/micro-macro-precision-recall-and-f-score-44439de1a044

Distilbert-base-uncased-emotion is a model fine-tuned for detecting emotions in texts, including sadness, joy, love, anger, fear and surprise.

Resource: https://huggingface.co/blog/sentiment-analysis-python

Exercise 3

LSTM Model

Kaggle Score 0.8945

https://keras.io/api/layers/recurrent_layers/lstm/

https://keras.io/api/preprocessing/text/#tokenizer-class

```
!pip install --upgrade keras tensorflow
!pip install -U scikit-learn
```

```
!pip install -U keras
!pip install -U tensorflow

Looking in indexes: https://pypi.org/simple, https://us-
python.pkg.dev/colab-wheels/public/simple/
Requirement already satisfied: keras in /usr/local/lib/python3.8/dist-
packages (2.11.0)
Requirement already satisfied: tensorflow in
/usr/local/lib/python3.8/dist-packages (2.11.0)
Requirement already satisfied: tensorflow-io-gcs-filesystem>=0.23.1 in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (0.31.0)
Requirement already satisfied: wrapt>=1.11.0 in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (1.15.0)
Requirement already satisfied: setuptools in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (57.4.0)
Requirement already satisfied: opt-einsum>=2.3.2 in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (3.3.0)
Requirement already satisfied: tensorboard<2.12,>=2.11 in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (2.11.2)
Requirement already satisfied: termcolor>=1.1.0 in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (2.2.0)
Requirement already satisfied: absl-py>=1.0.0 in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (1.4.0)
Requirement already satisfied: gast<=0.4.0,>=0.2.1 in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (0.4.0)
Requirement already satisfied: grpcio<2.0,>=1.24.3 in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (1.51.3)
Requirement already satisfied: protobuf<3.20,>=3.9.2 in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (3.19.6)
Requirement already satisfied: packaging in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (23.0)
Requirement already satisfied: libclang>=13.0.0 in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (15.0.6.1)
Requirement already satisfied: six>=1.12.0 in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (1.15.0)
Requirement already satisfied: h5py>=2.9.0 in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (3.1.0)
Requirement already satisfied: astunparse>=1.6.0 in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (1.6.3)
Requirement already satisfied: typing-extensions>=3.6.6 in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (4.5.0)
Requirement already satisfied: tensorflow-estimator<2.12,>=2.11.0
in /usr/local/lib/python3.8/dist-packages (from tensorflow) (2.11.0)
Requirement already satisfied: google-pasta>=0.1.1 in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (0.2.0)
Requirement already satisfied: numpy>=1.20 in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (1.24.2)
Requirement already satisfied: flatbuffers>=2.0 in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (23.1.21)
Requirement already satisfied: wheel<1.0,>=0.23.0 in
```

/usr/local/lib/python3.8/dist-packages (from astunparse>=1.6.0->tensorflow) (0.38.4)
Requirement already satisfied: werkzeug>=1.0.1 in
/usr/local/lib/python3.8/dist-packages (from tensorboard<2.12,>=2.11->tensorflow) (2.2.3)
Requirement already satisfied: markdown>=2.6.8 in
/usr/local/lib/python3.8/dist-packages (from tensorboard<2.12,>=2.11->tensorflow) (3.4.1)
Requirement already satisfied: tensorboard-plugin-wit>=1.6.0 in
/usr/local/lib/python3.8/dist-packages (from tensorboard<2.12,>=2.11->tensorflow) (1.8.1)
Requirement already satisfied: tensorboard-data-server<0.7.0,>=0.6.0
in /usr/local/lib/python3.8/dist-packages (from
tensorboard<2.12,>=2.11->tensorflow) (0.6.1)
Requirement already satisfied: requests<3,>=2.21.0 in
/usr/local/lib/python3.8/dist-packages (from tensorboard<2.12,>=2.11->tensorflow) (2.25.1)
Requirement already satisfied: google-auth<3,>=1.6.3 in
/usr/local/lib/python3.8/dist-packages (from tensorboard<2.12,>=2.11->tensorflow) (2.16.1)
Requirement already satisfied: google-auth-oauthlib<0.5,>=0.4.1 in
/usr/local/lib/python3.8/dist-packages (from tensorboard<2.12,>=2.11->tensorflow) (0.4.6)
Requirement already satisfied: pyasn1-modules>=0.2.1 in
/usr/local/lib/python3.8/dist-packages (from google-auth<3,>=1.6.3->tensorboard<2.12,>=2.11->tensorflow) (0.2.8)
Requirement already satisfied: rsa<5,>=3.1.4 in
/usr/local/lib/python3.8/dist-packages (from google-auth<3,>=1.6.3->tensorboard<2.12,>=2.11->tensorflow) (4.9)
Requirement already satisfied: cachetools<6.0,>=2.0.0 in
/usr/local/lib/python3.8/dist-packages (from google-auth<3,>=1.6.3->tensorboard<2.12,>=2.11->tensorflow) (5.3.0)
Requirement already satisfied: requests-oauthlib>=0.7.0 in
/usr/local/lib/python3.8/dist-packages (from google-auth-oauthlib<0.5,>=0.4.1->tensorboard<2.12,>=2.11->tensorflow) (1.3.1)
Requirement already satisfied: importlib-metadata>=4.4 in
/usr/local/lib/python3.8/dist-packages (from markdown>=2.6.8->tensorboard<2.12,>=2.11->tensorflow) (6.0.0)
Requirement already satisfied: idna<3,>=2.5 in
/usr/local/lib/python3.8/dist-packages (from requests<3,>=2.21.0->tensorboard<2.12,>=2.11->tensorflow) (2.10)
Requirement already satisfied: chardet<5,>=3.0.2 in
/usr/local/lib/python3.8/dist-packages (from requests<3,>=2.21.0->tensorboard<2.12,>=2.11->tensorflow) (4.0.0)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in
/usr/local/lib/python3.8/dist-packages (from requests<3,>=2.21.0->tensorboard<2.12,>=2.11->tensorflow) (1.26.14)
Requirement already satisfied: certifi>=2017.4.17 in
/usr/local/lib/python3.8/dist-packages (from requests<3,>=2.21.0->tensorboard<2.12,>=2.11->tensorflow) (2022.12.7)

Requirement already satisfied: MarkupSafe>=2.1.1 in
/usr/local/lib/python3.8/dist-packages (from werkzeug>=1.0.1-
>tensorboard<2.12,>=2.11->tensorflow) (2.1.2)
Requirement already satisfied: zipp>=0.5 in
/usr/local/lib/python3.8/dist-packages (from importlib-metadata>=4.4-
>markdown>=2.6.8->tensorboard<2.12,>=2.11->tensorflow) (3.15.0)
Requirement already satisfied: pyasn1<0.5.0,>=0.4.6 in
/usr/local/lib/python3.8/dist-packages (from pyasn1-modules>=0.2.1-
>google-auth<3,>=1.6.3->tensorboard<2.12,>=2.11->tensorflow) (0.4.8)
Requirement already satisfied: oauthlib>=3.0.0 in
/usr/local/lib/python3.8/dist-packages (from requests-oauthlib>=0.7.0-
>google-auth-oauthlib<0.5,>=0.4.1->tensorboard<2.12,>=2.11-
>tensorflow) (3.2.2)
Looking in indexes: https://pypi.org/simple, https://us-
python.pkg.dev/colab-wheels/public/simple/
Requirement already satisfied: scikit-learn in
/usr/local/lib/python3.8/dist-packages (1.2.1)
Requirement already satisfied: joblib>=1.1.1 in
/usr/local/lib/python3.8/dist-packages (from scikit-learn) (1.2.0)
Requirement already satisfied: numpy>=1.17.3 in
/usr/local/lib/python3.8/dist-packages (from scikit-learn) (1.24.2)
Requirement already satisfied: scipy>=1.3.2 in
/usr/local/lib/python3.8/dist-packages (from scikit-learn) (1.10.1)
Requirement already satisfied: threadpoolctl>=2.0.0 in
/usr/local/lib/python3.8/dist-packages (from scikit-learn) (3.1.0)
Looking in indexes: https://pypi.org/simple, https://us-
python.pkg.dev/colab-wheels/public/simple/
Requirement already satisfied: keras in /usr/local/lib/python3.8/dist-
packages (2.11.0)
Looking in indexes: https://pypi.org/simple, https://us-
python.pkg.dev/colab-wheels/public/simple/
Requirement already satisfied: tensorflow in
/usr/local/lib/python3.8/dist-packages (2.11.0)
Requirement already satisfied: tensorflow-estimator<2.12,>=2.11.0
in /usr/local/lib/python3.8/dist-packages (from tensorflow) (2.11.0)
Requirement already satisfied: libclang>=13.0.0 in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (15.0.6.1)
Requirement already satisfied: packaging in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (23.0)
Requirement already satisfied: grpcio<2.0,>=1.24.3 in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (1.51.3)
Requirement already satisfied: gast<=0.4.0,>=0.2.1 in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (0.4.0)
Requirement already satisfied: keras<2.12,>=2.11.0 in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (2.11.0)
Requirement already satisfied: protobuf<3.20,>=3.9.2 in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (3.19.6)
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Requirement already satisfied: h5py>=2.9.0 in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (3.1.0)
Requirement already satisfied: termcolor>=1.1.0 in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (2.2.0)
Requirement already satisfied: tensorflow-io-gcs-filesystem>=0.23.1 in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (0.31.0)
Requirement already satisfied: google-pasta>=0.1.1 in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (0.2.0)
Requirement already satisfied: flatbuffers>=2.0 in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (23.1.21)
Requirement already satisfied: six>=1.12.0 in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (1.15.0)
Requirement already satisfied: astunparse>=1.6.0 in
/usr/local/lib/python3.8/dist-packages (from tensorflow) (1.6.3)
Requirement already satisfied: wheel<1.0,>=0.23.0 in
/usr/local/lib/python3.8/dist-packages (from astunparse>=1.6.0-
>tensorflow) (0.38.4)
Requirement already satisfied: tensorboard-data-server<0.7.0,>=0.6.0
in /usr/local/lib/python3.8/dist-packages (from
tensorboard<2.12,>=2.11->tensorflow) (0.6.1)
Requirement already satisfied: werkzeug>=1.0.1 in
/usr/local/lib/python3.8/dist-packages (from tensorboard<2.12,>=2.11-
>tensorflow) (2.2.3)
Requirement already satisfied: markdown>=2.6.8 in
/usr/local/lib/python3.8/dist-packages (from tensorboard<2.12,>=2.11-
>tensorflow) (3.4.1)
Requirement already satisfied: google-auth<3,>=1.6.3 in
/usr/local/lib/python3.8/dist-packages (from tensorboard<2.12,>=2.11-
>tensorflow) (2.16.1)
Requirement already satisfied: tensorboard-plugin-wit>=1.6.0 in
/usr/local/lib/python3.8/dist-packages (from tensorboard<2.12,>=2.11-
>tensorflow) (1.8.1)
Requirement already satisfied: requests<3,>=2.21.0 in
/usr/local/lib/python3.8/dist-packages (from tensorboard<2.12,>=2.11-
>tensorflow) (2.25.1)
Requirement already satisfied: google-auth-oauthlib<0.5,>=0.4.1 in
/usr/local/lib/python3.8/dist-packages (from tensorboard<2.12,>=2.11-
>tensorflow) (0.4.6)
Requirement already satisfied: pyasn1-modules>=0.2.1 in

/usr/local/lib/python3.8/dist-packages (from google-auth<3,>=1.6.3-
>tensorboard<2.12,>=2.11->tensorflow) (0.2.8)
Requirement already satisfied: cachetools<6.0,>=2.0.0 in
/usr/local/lib/python3.8/dist-packages (from google-auth<3,>=1.6.3-
>tensorboard<2.12,>=2.11->tensorflow) (5.3.0)
Requirement already satisfied: rsa<5,>=3.1.4 in
/usr/local/lib/python3.8/dist-packages (from google-auth<3,>=1.6.3-
>tensorboard<2.12,>=2.11->tensorflow) (4.9)
Requirement already satisfied: requests-oauthlib>=0.7.0 in
/usr/local/lib/python3.8/dist-packages (from google-auth-
oauthlib<0.5,>=0.4.1->tensorboard<2.12,>=2.11->tensorflow) (1.3.1)
Requirement already satisfied: importlib-metadata>=4.4 in
/usr/local/lib/python3.8/dist-packages (from markdown>=2.6.8-
>tensorboard<2.12,>=2.11->tensorflow) (6.0.0)
Requirement already satisfied: idna<3,>=2.5 in
/usr/local/lib/python3.8/dist-packages (from requests<3,>=2.21.0-
>tensorboard<2.12,>=2.11->tensorflow) (2.10)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in
/usr/local/lib/python3.8/dist-packages (from requests<3,>=2.21.0-
>tensorboard<2.12,>=2.11->tensorflow) (1.26.14)
Requirement already satisfied: certifi>=2017.4.17 in
/usr/local/lib/python3.8/dist-packages (from requests<3,>=2.21.0-
>tensorboard<2.12,>=2.11->tensorflow) (2022.12.7)
Requirement already satisfied: chardet<5,>=3.0.2 in
/usr/local/lib/python3.8/dist-packages (from requests<3,>=2.21.0-
>tensorboard<2.12,>=2.11->tensorflow) (4.0.0)
Requirement already satisfied: MarkupSafe>=2.1.1 in
/usr/local/lib/python3.8/dist-packages (from werkzeug>=1.0.1-
>tensorboard<2.12,>=2.11->tensorflow) (2.1.2)
Requirement already satisfied: zipp>=0.5 in
/usr/local/lib/python3.8/dist-packages (from importlib-metadata>=4.4-
>markdown>=2.6.8->tensorboard<2.12,>=2.11->tensorflow) (3.15.0)
Requirement already satisfied: pyasn1<0.5.0,>=0.4.6 in
/usr/local/lib/python3.8/dist-packages (from pyasn1-modules>=0.2.1-
>google-auth<3,>=1.6.3->tensorboard<2.12,>=2.11->tensorflow) (0.4.8)
Requirement already satisfied: oauthlib>=3.0.0 in
/usr/local/lib/python3.8/dist-packages (from requests-oauthlib>=0.7.0-
>google-auth-oauthlib<0.5,>=0.4.1->tensorboard<2.12,>=2.11-
>tensorflow) (3.2.2)
```python
from tensorflow.keras.preprocessing.sequence import pad_sequences
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.metrics import accuracy_score, classification_report,
confusion_matrix, precision_score, recall_score, f1_score,
roc_auc_score

from tensorflow.keras.preprocessing.sequence import pad_sequences
```

```python
import pandas as pd
import numpy as np
from keras.preprocessing.text import Tokenizer
from keras.models import Sequential
from keras.layers import Embedding, LSTM, Dense
import nltk
from nltk.stem import WordNetLemmatizer
from nltk.corpus import stopwords
from nltk.stem import WordNetLemmatizer
import string

#-------------------------------------------------------------------
---------#
# Tokenizer: https://keras.io/api/preprocessing/text/
# Sequential model: https://keras.io/api/models/sequential/
# Embedding layer: https://keras.io/api/layers/core_layers/embedding/
# LSTM layer: https://keras.io/api/layers/recurrent_layers/lstm/
# Dense layer: https://keras.io/api/layers/core_layers/dense/
# compile method:
https://keras.io/api/models/model_training_apis/#compile-method
# fit method: https://keras.io/api/models/model_training_apis/#fit-
method
# pad_sequences function:
https://keras.io/api/preprocessing/timeseries/#pad_sequences-function
#-------------------------------------------------------------------
---------#
# load the training dataset
train_data = pd.read_csv('/content/Local_Dataset.csv')

#-------------------------------------------------------------------
---------#
nltk.download('stopwords')
nltk.download('wordnet')
# Defining stopwords and lemmatizer
stopwords = set(stopwords.words('english'))
lemmatizer = WordNetLemmatizer()
def text_processing(text):
#Convert to lowercase
#Remove punctuation
#Tokenize the text
#Remove stopwords
#Lemmatize the tokens
    text = text.lower()
    text = text.translate(str.maketrans('', '', string.punctuation))
    tokens = text.split()
    tokens = [token for token in tokens if token not in stopwords]
    tokens = [lemmatizer.lemmatize(token) for token in tokens]
    text = ' '.join(tokens)
    return text
```

```python
train_data['text'] = train_data['text'].apply(text_processing)
#-----------------------------------------------------------------
---------#
# tokenize the text data
tokenizer = Tokenizer()
tokenizer.fit_on_texts(train_data['text'])
train_seq = tokenizer.texts_to_sequences(train_data['text'])
train_pad_seq = pad_sequences(train_seq, maxlen=50, padding='post')
#-----------------------------------------------------------------
---------#
# create one-hot-encoded labels
train_labels = pd.get_dummies(train_data['label']).values
#-----------------------------------------------------------------
---------#
X_train, X_test, y_train, y_test = train_test_split(train_pad_seq,
train_labels, test_size=0.2, random_state=42)
X_val, X_test, y_val, y_test = train_test_split(X_test, y_test,
test_size=0.5, random_state=42)
#-----------------------------------------------------------------
---------#
# define the LSTM model
model = Sequential()
model.add(Embedding(len(tokenizer.word_index)+1, 32, input_length=50))
model.add(LSTM(64))
model.add(Dense(6, activation='softmax'))
#-----------------------------------------------------------------
---------#
# compile the model
model.compile(optimizer='adam', loss='categorical_crossentropy',
metrics=['accuracy'])
#-----------------------------------------------------------------
---------#
# train the model
history = model.fit(X_train, y_train, validation_data = (X_val,
y_val), epochs=50, batch_size=64)
#-----------------------------------------------------------------
---------#

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

Epoch 1/50
200/200 [==============================] - 8s 28ms/step - loss: 1.5884
- accuracy: 0.3288 - val_loss: 1.5858 - val_accuracy: 0.3300
Epoch 2/50
200/200 [==============================] - 5s 26ms/step - loss: 1.4266
- accuracy: 0.3666 - val_loss: 1.2003 - val_accuracy: 0.4194
Epoch 3/50
200/200 [==============================] - 5s 26ms/step - loss: 1.0910
```

```
 - accuracy: 0.4389 - val_loss: 1.1411 - val_accuracy: 0.4444
Epoch 4/50
200/200 [==============================] - 5s 27ms/step - loss: 1.0118
 - accuracy: 0.4562 - val_loss: 1.1493 - val_accuracy: 0.4538
Epoch 5/50
200/200 [==============================] - 5s 27ms/step - loss: 0.9174
 - accuracy: 0.5540 - val_loss: 1.0692 - val_accuracy: 0.5450
Epoch 6/50
200/200 [==============================] - 5s 27ms/step - loss: 0.7474
 - accuracy: 0.6919 - val_loss: 0.9060 - val_accuracy: 0.6787
Epoch 7/50
200/200 [==============================] - 5s 27ms/step - loss: 0.5856
 - accuracy: 0.7673 - val_loss: 0.7874 - val_accuracy: 0.7331
Epoch 8/50
200/200 [==============================] - 5s 26ms/step - loss: 0.4708
 - accuracy: 0.8296 - val_loss: 0.7004 - val_accuracy: 0.7569
Epoch 9/50
200/200 [==============================] - 5s 26ms/step - loss: 0.3997
 - accuracy: 0.8664 - val_loss: 0.7002 - val_accuracy: 0.8094
Epoch 10/50
200/200 [==============================] - 5s 26ms/step - loss: 0.3614
 - accuracy: 0.8941 - val_loss: 0.7847 - val_accuracy: 0.7706
Epoch 11/50
200/200 [==============================] - 5s 26ms/step - loss: 0.6269
 - accuracy: 0.7641 - val_loss: 1.2795 - val_accuracy: 0.5069
Epoch 12/50
200/200 [==============================] - 5s 26ms/step - loss: 0.9882
 - accuracy: 0.5864 - val_loss: 1.0297 - val_accuracy: 0.6350
Epoch 13/50
200/200 [==============================] - 5s 26ms/step - loss: 0.5810
 - accuracy: 0.8258 - val_loss: 0.6554 - val_accuracy: 0.8194
Epoch 14/50
200/200 [==============================] - 5s 26ms/step - loss: 0.3118
 - accuracy: 0.9113 - val_loss: 0.5283 - val_accuracy: 0.8500
Epoch 15/50
200/200 [==============================] - 5s 26ms/step - loss: 0.3341
 - accuracy: 0.8931 - val_loss: 0.5424 - val_accuracy: 0.8356
Epoch 16/50
200/200 [==============================] - 5s 26ms/step - loss: 0.1889
 - accuracy: 0.9429 - val_loss: 0.5119 - val_accuracy: 0.8581
Epoch 17/50
200/200 [==============================] - 5s 26ms/step - loss: 0.1428
 - accuracy: 0.9607 - val_loss: 0.5428 - val_accuracy: 0.8556
Epoch 18/50
200/200 [==============================] - 5s 26ms/step - loss: 0.1107
 - accuracy: 0.9700 - val_loss: 0.4908 - val_accuracy: 0.8687
Epoch 19/50
200/200 [==============================] - 5s 26ms/step - loss: 0.1006
 - accuracy: 0.9722 - val_loss: 0.5919 - val_accuracy: 0.8425
Epoch 20/50
```

```
200/200 [==============================] - 5s 26ms/step - loss: 0.0858
- accuracy: 0.9773 - val_loss: 0.5216 - val_accuracy: 0.8637
Epoch 21/50
200/200 [==============================] - 5s 27ms/step - loss: 0.0682
- accuracy: 0.9836 - val_loss: 0.5241 - val_accuracy: 0.8675
Epoch 22/50
200/200 [==============================] - 5s 27ms/step - loss: 0.0669
- accuracy: 0.9827 - val_loss: 0.5568 - val_accuracy: 0.8712
Epoch 23/50
200/200 [==============================] - 5s 27ms/step - loss: 0.0600
- accuracy: 0.9849 - val_loss: 0.5391 - val_accuracy: 0.8675
Epoch 24/50
200/200 [==============================] - 6s 28ms/step - loss: 0.0517
- accuracy: 0.9869 - val_loss: 0.6156 - val_accuracy: 0.8619
Epoch 25/50
200/200 [==============================] - 5s 26ms/step - loss: 0.0495
- accuracy: 0.9874 - val_loss: 0.5816 - val_accuracy: 0.8700
Epoch 26/50
200/200 [==============================] - 5s 26ms/step - loss: 0.0447
- accuracy: 0.9884 - val_loss: 0.5993 - val_accuracy: 0.8675
Epoch 27/50
200/200 [==============================] - 5s 26ms/step - loss: 0.0450
- accuracy: 0.9891 - val_loss: 0.5812 - val_accuracy: 0.8681
Epoch 28/50
200/200 [==============================] - 5s 26ms/step - loss: 0.0460
- accuracy: 0.9885 - val_loss: 0.6480 - val_accuracy: 0.8562
Epoch 29/50
200/200 [==============================] - 5s 26ms/step - loss: 0.0414
- accuracy: 0.9892 - val_loss: 0.6391 - val_accuracy: 0.8631
Epoch 30/50
200/200 [==============================] - 5s 26ms/step - loss: 0.0433
- accuracy: 0.9889 - val_loss: 0.6666 - val_accuracy: 0.8619
Epoch 31/50
200/200 [==============================] - 5s 26ms/step - loss: 0.0480
- accuracy: 0.9864 - val_loss: 0.5824 - val_accuracy: 0.8694
Epoch 32/50
200/200 [==============================] - 5s 26ms/step - loss: 0.0388
- accuracy: 0.9897 - val_loss: 0.6278 - val_accuracy: 0.8644
Epoch 33/50
200/200 [==============================] - 5s 26ms/step - loss: 0.0301
- accuracy: 0.9920 - val_loss: 0.6260 - val_accuracy: 0.8662
Epoch 34/50
200/200 [==============================] - 5s 26ms/step - loss: 0.0259
- accuracy: 0.9936 - val_loss: 0.7248 - val_accuracy: 0.8562
Epoch 35/50
200/200 [==============================] - 5s 26ms/step - loss: 0.0314
- accuracy: 0.9912 - val_loss: 0.7015 - val_accuracy: 0.8581
Epoch 36/50
200/200 [==============================] - 5s 26ms/step - loss: 0.0273
- accuracy: 0.9927 - val_loss: 0.6931 - val_accuracy: 0.8594
```

```
Epoch 37/50
200/200 [==============================] - 5s 26ms/step - loss: 0.0242
- accuracy: 0.9937 - val_loss: 0.6546 - val_accuracy: 0.8669
Epoch 38/50
200/200 [==============================] - 5s 27ms/step - loss: 0.0222
- accuracy: 0.9937 - val_loss: 0.6391 - val_accuracy: 0.8706
Epoch 39/50
200/200 [==============================] - 5s 27ms/step - loss: 0.0230
- accuracy: 0.9934 - val_loss: 0.6883 - val_accuracy: 0.8606
Epoch 40/50
200/200 [==============================] - 5s 27ms/step - loss: 0.0266
- accuracy: 0.9921 - val_loss: 0.7279 - val_accuracy: 0.8512
Epoch 41/50
200/200 [==============================] - 5s 27ms/step - loss: 0.0218
- accuracy: 0.9932 - val_loss: 0.6964 - val_accuracy: 0.8650
Epoch 42/50
200/200 [==============================] - 5s 26ms/step - loss: 0.0205
- accuracy: 0.9945 - val_loss: 0.7517 - val_accuracy: 0.8606
Epoch 43/50
200/200 [==============================] - 5s 26ms/step - loss: 0.0184
- accuracy: 0.9945 - val_loss: 0.6957 - val_accuracy: 0.8644
Epoch 44/50
200/200 [==============================] - 5s 26ms/step - loss: 0.0242
- accuracy: 0.9930 - val_loss: 0.7289 - val_accuracy: 0.8531
Epoch 45/50
200/200 [==============================] - 5s 26ms/step - loss: 0.0212
- accuracy: 0.9933 - val_loss: 0.7349 - val_accuracy: 0.8619
Epoch 46/50
200/200 [==============================] - 5s 26ms/step - loss: 0.0215
- accuracy: 0.9929 - val_loss: 0.7071 - val_accuracy: 0.8644
Epoch 47/50
200/200 [==============================] - 5s 26ms/step - loss: 0.0182
- accuracy: 0.9943 - val_loss: 0.7376 - val_accuracy: 0.8725
Epoch 48/50
200/200 [==============================] - 5s 26ms/step - loss: 0.0192
- accuracy: 0.9938 - val_loss: 0.7119 - val_accuracy: 0.8669
Epoch 49/50
200/200 [==============================] - 5s 26ms/step - loss: 0.0164
- accuracy: 0.9943 - val_loss: 0.7461 - val_accuracy: 0.8669
Epoch 50/50
200/200 [==============================] - 5s 26ms/step - loss: 0.0216
- accuracy: 0.9938 - val_loss: 0.7414 - val_accuracy: 0.8656

# Test Set
pred = model.predict(X_test)
test_pred_labels = np.argmax(pred, axis=1)
y_test = pd.DataFrame(y_test).idxmax(axis=1)

print(classification_report(y_test, test_pred_labels))
print()
```

```python
print('Confusion Matrix: \n')
cf_matrix = confusion_matrix(y_test, test_pred_labels)
cm_display = ConfusionMatrixDisplay(confusion_matrix=cf_matrix,
display_labels = ['Sadness', 'Joy', 'Love', 'Anger', 'Fear',
'Surprise'])
cm_display.plot()
plt.show()

print('Precision = ', precision_score(y_test, test_pred_labels,
average='macro'))
print('Recall = ', recall_score(y_test, test_pred_labels,
average='macro'))
print('F1 Score = ', f1_score(y_test, test_pred_labels,
average='macro'))
```
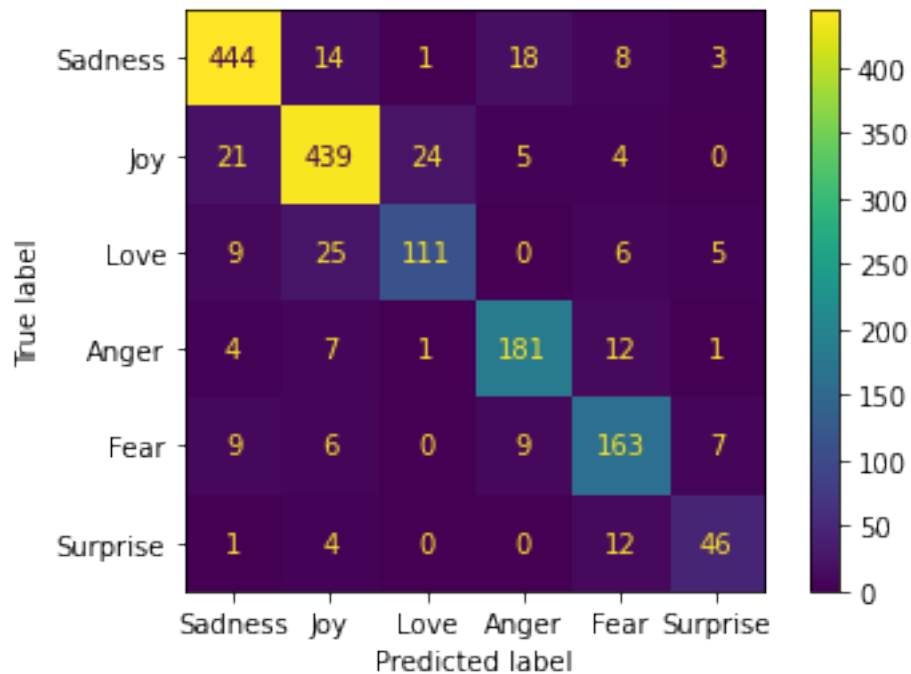
```
50/50 [==============================] - 1s 7ms/step
              precision    recall  f1-score   support

           0       0.91      0.91      0.91       488
           1       0.89      0.89      0.89       493
           2       0.81      0.71      0.76       156
           3       0.85      0.88      0.86       206
           4       0.80      0.84      0.82       194
           5       0.74      0.73      0.74        63

    accuracy                           0.86      1600
   macro avg       0.83      0.83      0.83      1600
weighted avg       0.86      0.86      0.86      1600


Confusion Matrix:
```

```
Precision =  0.8322910706418484
Recall =  0.8268077918295273
F1 Score =  0.8288639390718752
```

```python
#----------------------------------------------------------------------
---------#
# load the test dataset
test_data = pd.read_csv('/content/Kaggle1_Dataset.csv')
#----------------------------------------------------------------------
---------#
def text_processing(text):
#Convert to lowercase
#Remove punctuation
#Tokenize the text
#Remove stopwords
#Lemmatize the tokens
    text = text.lower()
    text = text.translate(str.maketrans('', '', string.punctuation))
    tokens = text.split()
    tokens = [token for token in tokens if token not in stopwords]
    tokens = [lemmatizer.lemmatize(token) for token in tokens]
    text = ' '.join(tokens)
    return text

test_data['text'] = test_data['text'].apply(text_processing)
# tokenize and pad the text data
test_seq = tokenizer.texts_to_sequences(test_data['text'])
test_pad_seq = pad_sequences(test_seq, maxlen=50, padding='post')
#----------------------------------------------------------------
```

```python
---------#
# make predictions on test data
test_pred = model.predict(test_pad_seq)
#-----------------------------------------------------------------------
---------#
# save the predictions to a csv file
test_pred_labels = np.argmax(test_pred, axis=1)
test_data['label'] = test_pred_labels
test_data.to_csv('test_pred.csv', index=False)
```

```
63/63 [==============================] - 1s 7ms/step
```

```python
def plotting_nn():
  metric = "accuracy"
  plt.figure()
  # summarize history for accuracy
  plt.plot(history.history['accuracy'])
  plt.plot(history.history['val_accuracy'])
  plt.title('model accuracy')
  plt.ylabel('accuracy')
  plt.xlabel('epoch')
  plt.legend(['Train', 'Validation'], loc='upper left')
  plt.show()
  # summarize history for loss
  plt.plot(history.history['loss'])
  plt.plot(history.history['val_loss'])
  plt.title('model loss')
  plt.ylabel('loss')
  plt.xlabel('epoch')
  plt.legend(['Train', 'Validation'], loc='upper left')
  plt.show()
  return plt.show()

plotting_nn()
```

model accuracy

model loss
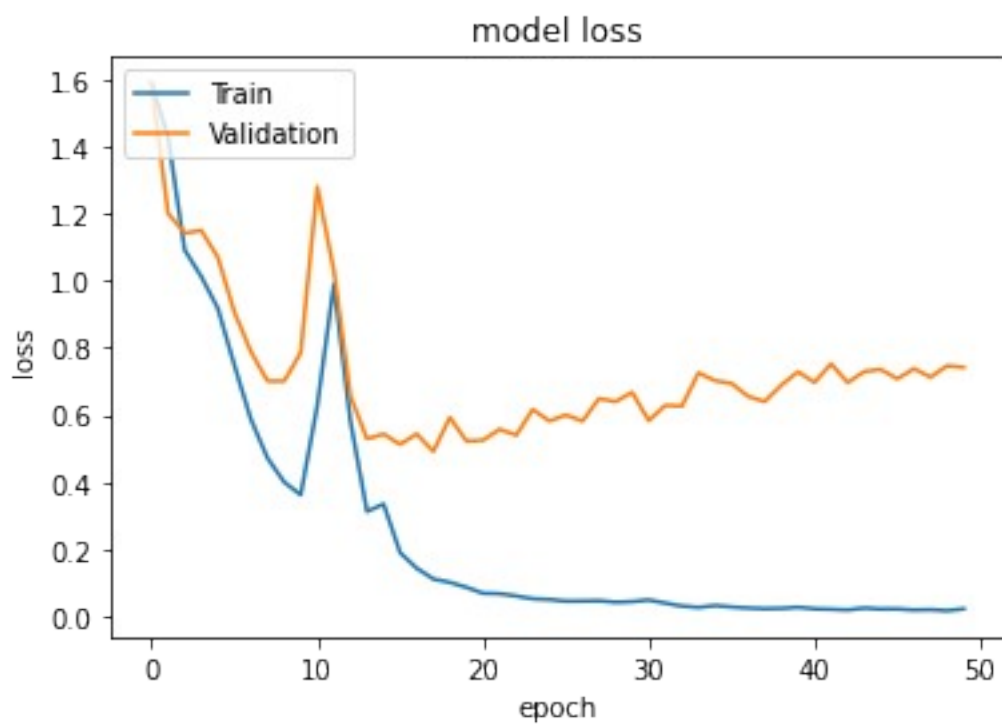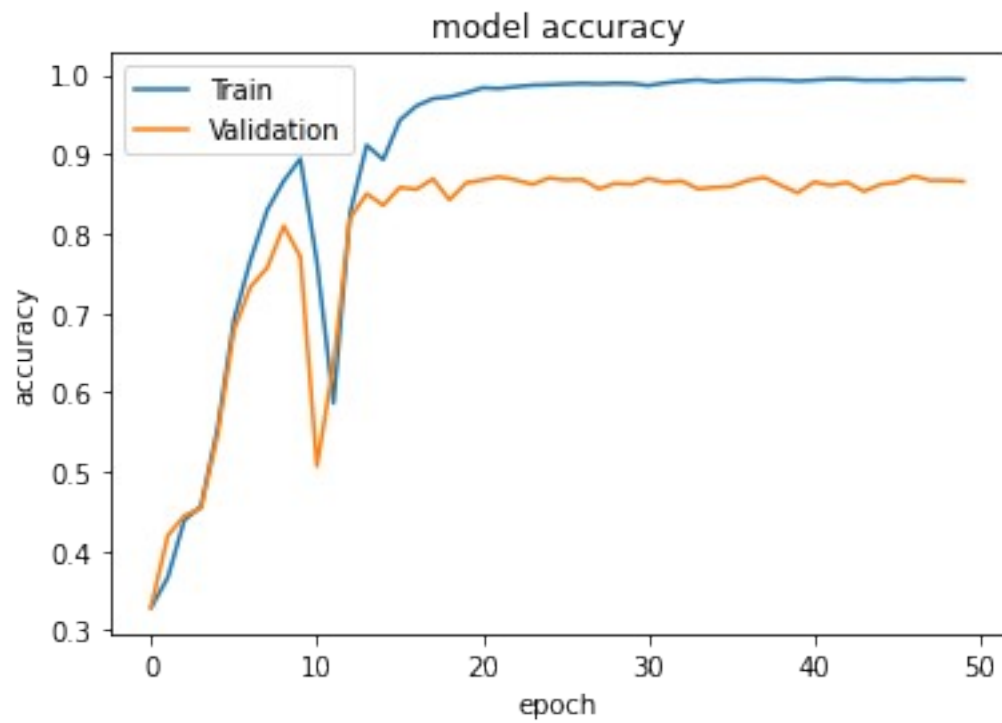
Exercise 4

Transformer Distilbert base uncased emotion for Kaggle 1

Self contained

```
pip install transformers

Looking in indexes: https://pypi.org/simple, https://us-
python.pkg.dev/colab-wheels/public/simple/
Collecting transformers
  Downloading transformers-4.27.1-py3-none-any.whl (6.7 MB)
━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 6.7/6.7 MB 50.3 MB/s eta
0:00:00
━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 199.2/199.2 KB 23.7 MB/s eta
0:00:00
ent already satisfied: filelock in /usr/local/lib/python3.9/dist-
packages (from transformers) (3.9.0)
Requirement already satisfied: pyyaml>=5.1 in
/usr/local/lib/python3.9/dist-packages (from transformers) (6.0)
Collecting tokenizers!=0.11.3,<0.14,>=0.11.1
  Downloading tokenizers-0.13.2-cp39-cp39-
manylinux_2_17_x86_64.manylinux2014_x86_64.whl (7.6 MB)
━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 7.6/7.6 MB 83.2 MB/s eta
0:00:00
ent already satisfied: tqdm>=4.27 in /usr/local/lib/python3.9/dist-
packages (from transformers) (4.65.0)
Requirement already satisfied: regex!=2019.12.17 in
/usr/local/lib/python3.9/dist-packages (from transformers) (2022.6.2)
Requirement already satisfied: packaging>=20.0 in
/usr/local/lib/python3.9/dist-packages (from transformers) (23.0)
Requirement already satisfied: requests in
/usr/local/lib/python3.9/dist-packages (from transformers) (2.25.1)
Requirement already satisfied: numpy>=1.17 in
/usr/local/lib/python3.9/dist-packages (from transformers) (1.24.2)
Requirement already satisfied: typing-extensions>=3.7.4.3 in
/usr/local/lib/python3.9/dist-packages (from huggingface-
hub<1.0,>=0.11.0->transformers) (4.5.0)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in
/usr/local/lib/python3.9/dist-packages (from requests->transformers)
(1.26.15)
Requirement already satisfied: certifi>=2017.4.17 in
/usr/local/lib/python3.9/dist-packages (from requests->transformers)
(2022.12.7)
Requirement already satisfied: chardet<5,>=3.0.2 in
/usr/local/lib/python3.9/dist-packages (from requests->transformers)
(4.0.0)
Requirement already satisfied: idna<3,>=2.5 in
/usr/local/lib/python3.9/dist-packages (from requests->transformers)
(2.10)
Installing collected packages: tokenizers, huggingface-hub,
```

```
transformers
Successfully installed huggingface-hub-0.13.2 tokenizers-0.13.2
transformers-4.27.1

from sklearn.metrics import classification_report, confusion_matrix,
accuracy_score
from transformers import pipeline
import pandas as pd
#
https://huggingface.co/docs/transformers/main_classes/pipelines#transf
ormers.pipeline
#
https://scikit-learn.org/stable/modules/generated/sklearn.metrics.clas
sification_report.html
#
https://scikit-learn.org/stable/modules/generated/sklearn.metrics.conf
usion_matrix.html
classifier = pipeline("text-classification",
                      model='bhadresh-savani/distilbert-base-uncased-
emotion',
                      tokenizer='distilbert-base-uncased')
# -----------------------------------------------------------------#
def transformer(df):

    # Applying it to the Text Column
    emotions = df['text'].apply(classifier)
# -----------------------------------------------------------------#
    # Extract the predicted emotion labels and scores
    predicted_emotions = emotions.apply(lambda x: x[0]['label'])
    predicted_scores = emotions.apply(lambda x: x[0]['score'])
# -----------------------------------------------------------------#
    # Combine the predicted emotion labels and scores into a dataframe
    df_predicted = pd.DataFrame({'text': df['text'],
                                 'predicted_emotion':
predicted_emotions,
                                 'predicted_score': predicted_scores})
    return df_predicted
# -----------------------------------------------------------------#
# The Datasets
labelinfo = {'sadness': 0, 'joy': 1, 'love': 2, 'anger': 3, 'fear': 4,
'surprise': 5}
train_df = pd.read_csv('/content/Local_Dataset.csv')
for i, num in enumerate(train_df['label']):
  for j in labelinfo:
    if labelinfo[j] == num:
      train_df['label'].loc[i] = j
test_df = pd.read_csv('/content/Kaggle1_Dataset.csv')
# -----------------------------------------------------------------#
X_train, X_test, y_train, y_test = train_test_split(train_df['text'],
train_df['label'], test_size=0.2, random_state=42)
```

```
X_val, X_test, y_val, y_test = train_test_split(X_test, y_test,
test_size=0.5, random_state=42)
#------------------------------------------------------------------#

<ipython-input-12-b4772fdde471>:32: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation:
https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#
returning-a-view-versus-a-copy
  train_df['label'].loc[i] = j

# Transform the datasets
# ------------------------------------------------------------------#
temp =  X_train.apply(classifier)
train_pred = temp.apply(lambda x: x[0]['label'])

temp = X_val.apply(classifier)
val_pred = temp.apply(lambda x: x[0]['label'])

temp = X_test.apply(classifier)
test_pred = temp.apply(lambda x: x[0]['label'])

train_df_transformed = transformer(train_df)
kaggle_df_transformed = transformer(test_df)
# ------------------------------------------------------------------#
# Metrics
def MetricReport(truth, pred):
  print("Training Classification Report: ")

  print(classification_report(truth,
                              pred,
                              zero_division=1))

  print("\nTraining Confusion Matrix: ")
  cf_matrix = confusion_matrix(truth, pred)
  cm_display = ConfusionMatrixDisplay(confusion_matrix=cf_matrix,
display_labels = ['Sadness', 'Joy', 'Love', 'Anger', 'Fear',
'Surprise'])
  cm_display.plot()
  plt.show()

  print('Accuracy = ', accuracy_score(truth, pred))
  print('Precision = ', precision_score(truth, pred, average='macro'))
  print('Recall = ', recall_score(truth, pred, average='macro'))
  print('F1 Score = ', f1_score(truth, pred, average='macro'))

print('Training')
MetricReport(y_train, train_pred)
print()
```

```python
print('Validation')
MetricReport(y_val, val_pred)
print()
print('Test')
MetricReport(y_test, test_pred)
```

Training
Training Classification Report:

	precision	recall	f1-score	support
anger	0.99	0.99	0.99	1732
fear	0.97	0.99	0.98	1540
joy	1.00	0.99	0.99	4341
love	0.95	0.99	0.97	1008
sadness	1.00	1.00	1.00	3720
surprise	0.96	0.92	0.94	459
accuracy			0.99	12800
macro avg	0.98	0.98	0.98	12800
weighted avg	0.99	0.99	0.99	12800

Training Confusion Matrix:
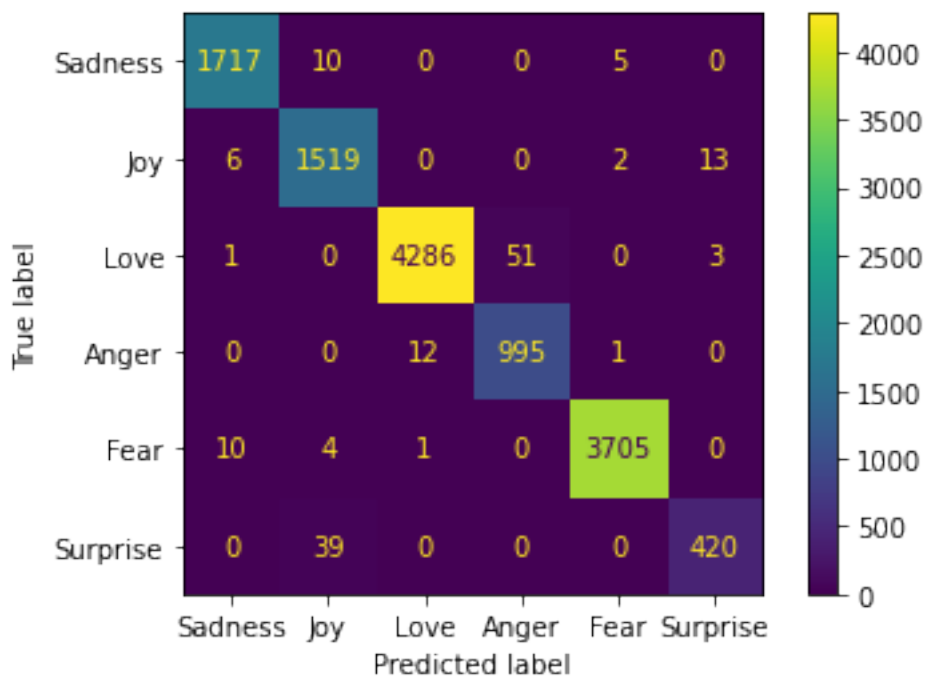
Accuracy = 0.98765625
Precision = 0.9776413494659715
Recall = 0.9771894721379502
F1 Score = 0.9772354377949437

Validation
Training Classification Report:

	precision	recall	f1-score	support
anger	0.99	1.00	0.99	221
fear	0.98	1.00	0.99	203
joy	1.00	0.99	1.00	528
love	0.98	0.99	0.99	140
sadness	1.00	1.00	1.00	458
surprise	1.00	0.92	0.96	50
accuracy			0.99	1600
macro avg	0.99	0.98	0.99	1600
weighted avg	0.99	0.99	0.99	1600

Training Confusion Matrix:
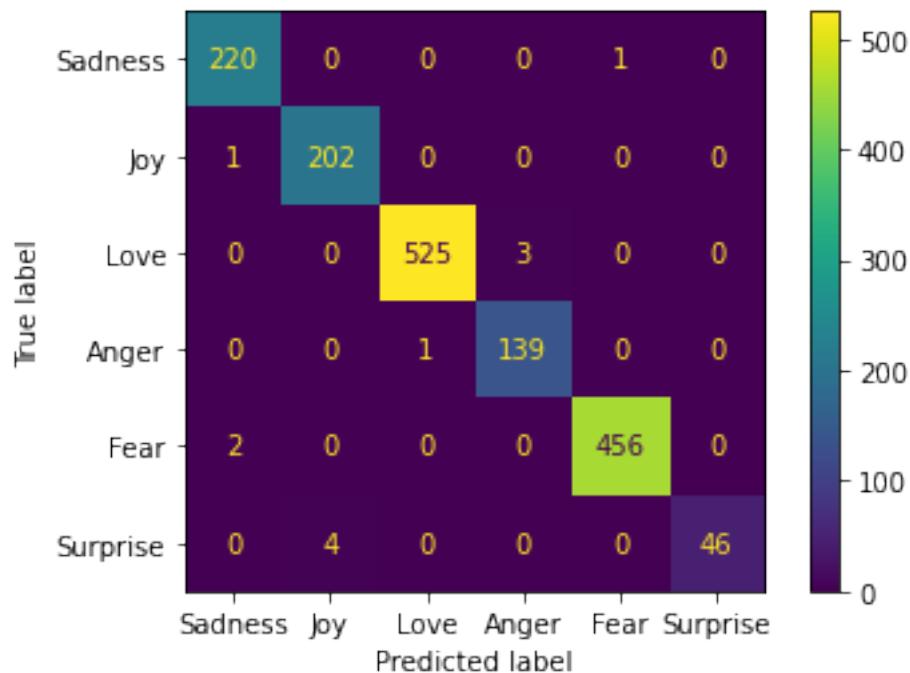
Accuracy = 0.9925
Precision = 0.9903189207364013
Recall = 0.9822262528660063
F1 Score = 0.9859735388912743

Test
Training Classification Report:

	precision	recall	f1-score	support
anger	1.00	0.99	0.99	206
fear	0.96	0.99	0.98	194

```
        joy          1.00        0.98        0.99         493
       love          0.95        1.00        0.97         156
    sadness          1.00        1.00        1.00         488
   surprise          0.98        0.94        0.96          63

   accuracy                                  0.99        1600
  macro avg          0.98        0.98        0.98        1600
weighted avg         0.99        0.99        0.99        1600
```

Training Confusion Matrix:
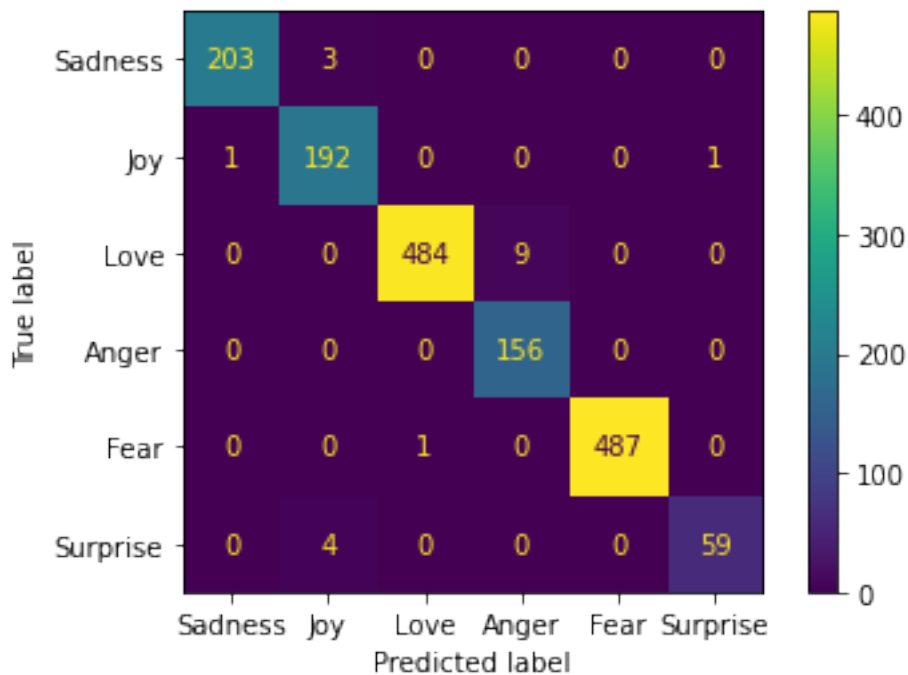

```
Accuracy =  0.988125
Precision =  0.9811080304894128
Recall =  0.9818884654900216
F1 Score =  0.9812341265829524
```

```python
# Train the model on the training dataset
train_predictions = train_df_transformed['text'].apply(lambda text:
classifier(text)[0]['label'])

train_report =
classification_report(train_df_transformed['predicted_emotion'],
                       train_predictions,
                       output_dict=True,
                       zero_division=1)

train_matrix =
confusion_matrix(train_df_transformed['predicted_emotion'],
```

```python
                                train_predictions)
# ----------------------------------------------------------------#
# Metrics
print("Training Classification Report: ")

print(classification_report(train_df_transformed['predicted_emotion'],
                            train_predictions,
                            zero_division=1))

print("\nTraining Confusion Matrix: ")
cm_display = ConfusionMatrixDisplay(confusion_matrix=train_matrix,
display_labels = ['Sadness', 'Joy', 'Love', 'Anger', 'Fear',
'Surprise'])
cm_display.plot()
plt.show()

accuracy = accuracy_score(train_df_transformed['predicted_emotion'],
                          train_predictions)

macro_precision = train_report['macro avg']['precision']
macro_recall = train_report['macro avg']['recall']
macro_f1 = train_report['macro avg']['f1-score']
print("\nTraining Accuracy: ", accuracy)
print("\nTraining Macro Precision:", macro_precision)
print("Training Macro Recall:", macro_recall)
print("Training Macro F1-score:", macro_f1)
# ----------------------------------------------------------------#
# Predicting on the test dataset and save the predictions
# Re wrote the classifier due to defining it outside the function

classifier = pipeline("text-classification",
                      model='bhadresh-savani/distilbert-base-uncased-
emotion',
                      tokenizer='distilbert-base-uncased')

test_predictions = test_df_transformed['text'].apply(lambda text:
classifier(text)[0]['label'])
test_df['label'] = test_predictions
```

```
Training Classification Report:
              precision    recall  f1-score   support

       anger       1.00      1.00      1.00      2161
        fear       1.00      1.00      1.00      1977
         joy       1.00      1.00      1.00      5310
        love       1.00      1.00      1.00      1353
     sadness       1.00      1.00      1.00      4657
    surprise       1.00      1.00      1.00       542

    accuracy                           1.00     16000
```

```
    macro avg        1.00       1.00       1.00      16000
weighted avg        1.00       1.00       1.00      16000
```

Training Confusion Matrix:
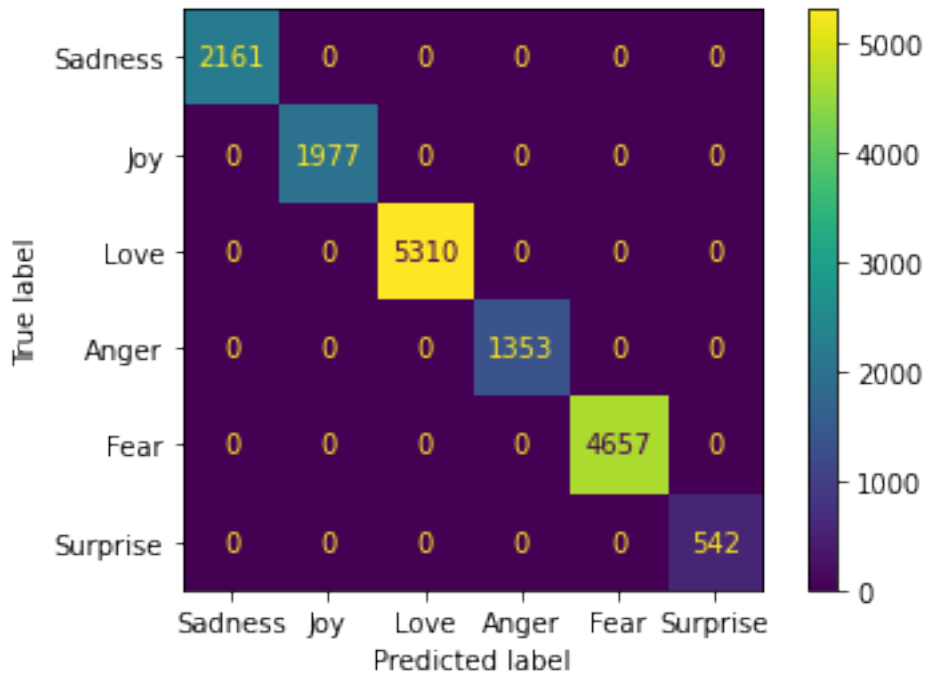
Training Accuracy: 1.0

Training Macro Precision: 1.0
Training Macro Recall: 1.0
Training Macro F1-score: 1.0

NameError   Traceback (most recent call
last)
<ipython-input-15-caa30ba94d0c> in <module>
     40   tokenizer='distilbert-base-uncased')
     41
---> 42 test_predictions = test_df_transformed['text'].apply(lambda
text: classifier(text)[0]['label'])
     43 test_df['label'] = test_predictions

NameError: name 'test_df_transformed' is not defined

test_df

```
        index                                                text
label
0           0  im feeling quite sad and sorry for myself but ...
sadness
1           1  i feel like i am still looking at a blank canv...
sadness
2           2                       i feel like a faithful servant
joy
3           3                       i am just feeling cranky and blue
anger
4           4  i can have for a treat or if i am feeling festive
joy
...       ...                                                ...      ..
.
1995     1995  im having ssa examination tomorrow in the morn...
sadness
1996     1996  i constantly worry about their fight against n...
joy
1997     1997  i feel its important to share this info for th...
joy
1998     1998  i truly feel that if you are passionate enough...
joy
1999     1999  i feel like i just wanna buy any cute make up ...
joy

[2000 rows x 3 columns]
```

```python
map = {'sadness': 0, 'joy': 1, 'love': 2, 'anger': 3, 'fear': 4,
'surprise': 5}

test_df['label'] = test_df['label'].map(map)

test_df
```

```
        index                                                text  label
0           0  im feeling quite sad and sorry for myself but ...      0
1           1  i feel like i am still looking at a blank canv...      0
2           2                       i feel like a faithful servant      1
3           3                       i am just feeling cranky and blue      3
4           4  i can have for a treat or if i am feeling festive      1
...       ...                                                ...    ...
1995     1995  im having ssa examination tomorrow in the morn...      0
1996     1996  i constantly worry about their fight against n...      1
1997     1997  i feel its important to share this info for th...      1
1998     1998  i truly feel that if you are passionate enough...      1
1999     1999  i feel like i just wanna buy any cute make up ...      1

[2000 rows x 3 columns]
```

```python
# Remove the text column then submit it
```

```python
a = pd.concat([pd.DataFrame(X_test), pd.DataFrame(y_test),
pd.DataFrame(test_pred)], axis = 1, ignore_index=True)
a.columns = ['text', 'truth', 'predictions']
df_new = a[a['truth'] != a['predictions']]

for i in range(4):
  print(df_new['text'].iloc[i+7])
  print('Truth:', df_new['truth'].iloc[i+7])
  print('Prediction:', df_new['predictions'].iloc[i+7])
  print()
```

Transformer for Zero Shot for Kaggle 2

Required Preprocessing and Libraries

```python
df = pd.read_csv('/content/Local_Dataset.csv')
df_test = pd.read_csv('/content/Kaggle2_Dataset.csv')

display(df)
print()
display(df_test)
```

```
                                                  text  label
0                           i didnt feel humiliated      0
1      i can go from feeling so hopeless to so damned...    0
2       im grabbing a minute to post i feel greedy wrong    3
3      i am ever feeling nostalgic about the fireplac...    2
4                              i am feeling grouchy       3
...                                                ...    ...
15995  i just had a very brief time in the beanbag an...    0
15996  i am now turning and i feel pathetic that i am...    0
15997                    i feel strong and good overall    1
15998  i feel like this was such a rude comment and i...    3
15999  i know a lot but i feel so stupid because i ca...    0

[16000 rows x 2 columns]
```

```
       index                                               text  \
0          0  im feeling rather rotten so im not very ambiti...
1          1           im updating my blog because i feel shitty
2          2  i never make her separate from me because i do...
3          3  i left with my bouquet of red and yellow tulip...
4          4    i was feeling a little vain when i did this one
...      ...                                                ...
1995    1995  i just keep feeling like someone is being unki...
1996    1996  im feeling a little cranky negative after this...
1997    1997  i feel that i am useful to my people and that ...
1998    1998  im feeling more comfortable with derby i feel ...
1999    1999  i feel all weird when i have to meet w people ...
```

```
                                        possible_emotions
0       ['alarm', 'exasperation', 'terror', 'tendernes...
1       ['shock', 'jubilation', 'shock', 'fright', 'fr...
2       ['panic', 'shock', 'exultation', 'fright', 'jo...
3       ['attachment', 'annoyance', 'exasperation', 'i...
4       ['tenderness', 'tenderness', 'exultation', 'tr...
...                                                   ...
1995    ['jubilation', 'fondness', 'depression', 'stag...
1996    ['alarm', 'warmth', 'tenderness', 'depression'...
1997    ['sorrow', 'fright', 'intimacy', 'stun', 'depr...
1998    ['depression', 'stun', 'warmth', 'annoyance', ...
1999    ['shock', 'vexation', 'warmth', 'unhappiness',...

[2000 rows x 3 columns]
```

```python
!pip uninstall nltk
!pip install nltk
import nltk
nltk.download('omw-1.4')
```

```
Found existing installation: nltk 3.7
Uninstalling nltk-3.7:
  Would remove:
    /usr/local/bin/nltk
    /usr/local/lib/python3.9/dist-packages/nltk-3.7.dist-info/*
    /usr/local/lib/python3.9/dist-packages/nltk/*
Proceed (Y/n)? Y
  Successfully uninstalled nltk-3.7
Looking in indexes: https://pypi.org/simple, https://us-
python.pkg.dev/colab-wheels/public/simple/
Collecting nltk
  Downloading nltk-3.8.1-py3-none-any.whl (1.5 MB)
━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 1.5/1.5 MB 20.9 MB/s eta
0:00:00
ent already satisfied: click in /usr/local/lib/python3.9/dist-packages
(from nltk) (8.1.3)
Requirement already satisfied: tqdm in /usr/local/lib/python3.9/dist-
packages (from nltk) (4.65.0)
Requirement already satisfied: joblib in
/usr/local/lib/python3.9/dist-packages (from nltk) (1.1.1)
Requirement already satisfied: regex>=2021.8.3 in
/usr/local/lib/python3.9/dist-packages (from nltk) (2022.6.2)
Installing collected packages: nltk
Successfully installed nltk-3.8.1
```

{"pip_warning":{"packages":["nltk"]}}

```
[nltk_data] Downloading package omw-1.4 to /root/nltk_data...

True
```

```python
from nltk.stem import WordNetLemmatizer
from nltk.corpus import stopwords
from nltk.stem import WordNetLemmatizer
import string

nltk.download('stopwords')
nltk.download('wordnet')

# Defining stopwords and lemmatizer
stopwords = set(stopwords.words('english'))
lemmatizer = WordNetLemmatizer()


def text_processing(text):


#Convert to lowercase
#Remove punctuation
#Tokenize the text
#Remove stopwords
#Lemmatize the tokens


    text = text.lower()

    text = text.translate(str.maketrans('', '', string.punctuation))

    tokens = text.split()

    tokens = [token for token in tokens if token not in stopwords]

    tokens = [lemmatizer.lemmatize(token) for token in tokens]
    text = ' '.join(tokens)
    return text

df['text'] = df['text'].apply(text_processing)
df_test['text'] = df_test['text'].apply(text_processing)
```

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

```python
# Print the preprocessed dataframes
display(df)
print()
display(df_test)
```

	text	label
0	didnt feel humiliated	0

```
1        go feeling hopeless damned hopeful around some...    0
2                im grabbing minute post feel greedy wrong    3
3        ever feeling nostalgic fireplace know still pr...    2
4                                           feeling grouchy    3
...                                                     ...  ...
15995       brief time beanbag said anna feel like beaten    0
15996   turning feel pathetic still waiting table subb...    0
15997                              feel strong good overall    1
15998                          feel like rude comment im glad    3
15999                            know lot feel stupid portray    0

[16000 rows x 2 columns]


        index                                              text  \
0           0        im feeling rather rotten im ambitious right
1           1                       im updating blog feel shitty
2           2   never make separate ever want feel like ashamed
3           3   left bouquet red yellow tulip arm feeling slig...
4           4                              feeling little vain one
...       ...                                               ...
1995     1995   keep feeling like someone unkind wrong think g...
1996     1996   im feeling little cranky negative doctor appoi...
1997     1997   feel useful people give great feeling achievement
1998     1998   im feeling comfortable derby feel though start...
1999     1999   feel weird meet w people text like dont talk f...

                              possible_emotions
0      ['alarm', 'exasperation', 'terror', 'tendernes...
1      ['shock', 'jubilation', 'shock', 'fright', 'fr...
2      ['panic', 'shock', 'exultation', 'fright', 'jo...
3      ['attachment', 'annoyance', 'exasperation', 'i...
4      ['tenderness', 'tenderness', 'exultation', 'tr...
...                                                 ...
1995   ['jubilation', 'fondness', 'depression', 'stag...
1996   ['alarm', 'warmth', 'tenderness', 'depression'...
1997   ['sorrow', 'fright', 'intimacy', 'stun', 'depr...
1998   ['depression', 'stun', 'warmth', 'annoyance', ...
1999   ['shock', 'vexation', 'warmth', 'unhappiness',...

[2000 rows x 3 columns]

!pip install transformers

Looking in indexes: https://pypi.org/simple, https://us-
python.pkg.dev/colab-wheels/public/simple/
Requirement already satisfied: transformers in
/usr/local/lib/python3.9/dist-packages (4.26.1)
Requirement already satisfied: packaging>=20.0 in
/usr/local/lib/python3.9/dist-packages (from transformers) (23.0)
```

```
Requirement already satisfied: filelock in
/usr/local/lib/python3.9/dist-packages (from transformers) (3.9.0)
Requirement already satisfied: tqdm>=4.27 in
/usr/local/lib/python3.9/dist-packages (from transformers) (4.65.0)
Requirement already satisfied: pyyaml>=5.1 in
/usr/local/lib/python3.9/dist-packages (from transformers) (6.0)
Requirement already satisfied: huggingface-hub<1.0,>=0.11.0 in
/usr/local/lib/python3.9/dist-packages (from transformers) (0.13.2)
Requirement already satisfied: regex!=2019.12.17 in
/usr/local/lib/python3.9/dist-packages (from transformers) (2022.6.2)
Requirement already satisfied: tokenizers!=0.11.3,<0.14,>=0.11.1 in
/usr/local/lib/python3.9/dist-packages (from transformers) (0.13.2)
Requirement already satisfied: numpy>=1.17 in
/usr/local/lib/python3.9/dist-packages (from transformers) (1.24.2)
Requirement already satisfied: requests in
/usr/local/lib/python3.9/dist-packages (from transformers) (2.25.1)
Requirement already satisfied: typing-extensions>=3.7.4.3 in
/usr/local/lib/python3.9/dist-packages (from huggingface-
hub<1.0,>=0.11.0->transformers) (4.5.0)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in
/usr/local/lib/python3.9/dist-packages (from requests->transformers)
(1.26.15)
Requirement already satisfied: certifi>=2017.4.17 in
/usr/local/lib/python3.9/dist-packages (from requests->transformers)
(2022.12.7)
Requirement already satisfied: idna<3,>=2.5 in
/usr/local/lib/python3.9/dist-packages (from requests->transformers)
(2.10)
Requirement already satisfied: chardet<5,>=3.0.2 in
/usr/local/lib/python3.9/dist-packages (from requests->transformers)
(4.0.0)
```

Failed Attempt:

Trying to use every emotion against every text Failed due to computational limitations

```python
import ast
# Documentation: https://docs.python.org/3/library/ast.html
# Extracting all the emotions
# Removing duplicates and sort the emotions in alphabetical order

all_emotions = [emotion for emotions in df_test['possible_emotions']
for emotion in ast.literal_eval(emotions)]
unique_emotions = sorted(list(set(all_emotions)))


unique_emotions

['alarm',
 'annoyance',
 'astound',
```

```
  'attachment',
  'crossness',
  'dejection',
  'delight',
  'depression',
  'exasperation',
  'exultation',
  'flabbergast',
  'fondness',
  'fright',
  'horror',
  'intimacy',
  'irritation',
  'joyfulness',
  'jubilation',
  'panic',
  'regret',
  'shock',
  'sorrow',
  'stagger',
  'stun',
  'tenderness',
  'terror',
  'triumph',
  'unhappiness',
  'vexation',
  'warmth']

from transformers import pipeline
import pandas as pd

# Load the zero-shot classification pipeline
# Define the emotions to classify the text into

classifier = pipeline("zero-shot-classification")
possible_emotions = ['alarm',
 'annoyance',
 'astound',
 'attachment',
 'crossness',
 'dejection',
 'delight',
 'depression',
 'exasperation',
 'exultation',
 'flabbergast',
 'fondness',
 'fright',
 'horror',
 'intimacy',
```

```
  'irritation',
  'joyfulness',
  'jubilation',
  'panic',
  'regret',
  'shock',
  'sorrow',
  'stagger',
  'stun',
  'tenderness',
  'terror',
  'triumph',
  'unhappiness',
  'vexation',
  'warmth']

# Use the classifier to predict the most likely emotion for each row
predicted_emotions = []
for i, row in df_test_cut.iterrows():
    text = row["text"]
    possible_emotions = ast.literal_eval(row["possible_emotions"])
    max_score = -1
    predicted_emotion = ""
    for emotion in possible_emotions:
        result = classifier(text, emotion)
        if result["scores"][0] > max_score:
            max_score = result["scores"][0]
            predicted_emotion = result["labels"][0]
    predicted_emotions.append(predicted_emotion)

# Add the predicted emotions to the test dataframe
df_test["predicted_emotion"] = predicted_emotions

# Save the results to a CSV file
df_test.to_csv('/path/to/predictions2.csv', index=False)

No model was supplied, defaulted to facebook/bart-large-mnli and
revision c626438 (https://huggingface.co/facebook/bart-large-mnli).
Using a pipeline without specifying a model name and revision in
production is not recommended.

---------------------------------------------------------------------
-----
KeyboardInterrupt                         Traceback (most recent call
last)
<ipython-input-31-6c0609c9fc0d> in <module>
     41 for i, row in df_test.iterrows():
     42     text = row["text"]
---> 43     result = classifier(text, possible_emotions)
     44     predicted_emotion = result["labels"][0]
```

```
     45         predicted_emotions.append(predicted_emotion)

/usr/local/lib/python3.9/dist-packages/transformers/pipelines/zero_sho
t_classification.py in __call__(self, sequences, *args, **kwargs)
    203             raise ValueError(f"Unable to understand extra
arguments {args}")
    204
--> 205         return super().__call__(sequences, **kwargs)
    206
    207     def preprocess(self, inputs, candidate_labels=None,
hypothesis_template="This example is {}."):

/usr/local/lib/python3.9/dist-packages/transformers/pipelines/base.py
in __call__(self, inputs, num_workers, batch_size, *args, **kwargs)
    1074             return self.iterate(inputs, preprocess_params,
forward_params, postprocess_params)
    1075         elif self.framework == "pt" and isinstance(self,
ChunkPipeline):
-> 1076             return next(
    1077                 iter(
    1078                     self.get_iterator(

/usr/local/lib/python3.9/dist-packages/transformers/pipelines/pt_utils
.py in __next__(self)
    122
    123         # We're out of items within a batch
--> 124         item = next(self.iterator)
    125         processed = self.infer(item, **self.params)
    126         # We now have a batch of "inferred things".

/usr/local/lib/python3.9/dist-packages/transformers/pipelines/pt_utils
.py in __next__(self)
    264
    265         while not is_last:
--> 266             processed = self.infer(next(self.iterator),
**self.params)
    267             if self.loader_batch_size is not None:
    268                 if isinstance(processed, torch.Tensor):

/usr/local/lib/python3.9/dist-packages/transformers/pipelines/base.py
in forward(self, model_inputs, **forward_params)
    990                 with inference_context():
    991                     model_inputs =
self._ensure_tensor_on_device(model_inputs, device=self.device)
--> 992                     model_outputs =
self._forward(model_inputs, **forward_params)
    993                     model_outputs =
self._ensure_tensor_on_device(model_outputs,
device=torch.device("cpu"))
    994                 else:
```

```
/usr/local/lib/python3.9/dist-packages/transformers/pipelines/zero_sho
t_classification.py in _forward(self, inputs)
    222             sequence = inputs["sequence"]
    223             model_inputs = {k: inputs[k] for k in
self.tokenizer.model_input_names}
--> 224             outputs = self.model(**model_inputs)
    225
    226             model_outputs = {

/usr/local/lib/python3.9/dist-packages/torch/nn/modules/module.py in
_call_impl(self, *input, **kwargs)
   1192             if not (self._backward_hooks or self._forward_hooks or
self._forward_pre_hooks or _global_backward_hooks
   1193                     or _global_forward_hooks or
_global_forward_pre_hooks):
-> 1194                 return forward_call(*input, **kwargs)
   1195             # Do not call functions when jit is used
   1196             full_backward_hooks, non_full_backward_hooks = [], []

/usr/local/lib/python3.9/dist-packages/transformers/models/bart/modeli
ng_bart.py in forward(self, input_ids, attention_mask,
decoder_input_ids, decoder_attention_mask, head_mask,
decoder_head_mask, cross_attn_head_mask, encoder_outputs,
inputs_embeds, decoder_inputs_embeds, labels, use_cache,
output_attentions, output_hidden_states, return_dict)
   1520             )
   1521
-> 1522         outputs = self.model(
   1523             input_ids,
   1524             attention_mask=attention_mask,

/usr/local/lib/python3.9/dist-packages/torch/nn/modules/module.py in
_call_impl(self, *input, **kwargs)
   1192             if not (self._backward_hooks or self._forward_hooks or
self._forward_pre_hooks or _global_backward_hooks
   1193                     or _global_forward_hooks or
_global_forward_pre_hooks):
-> 1194                 return forward_call(*input, **kwargs)
   1195             # Do not call functions when jit is used
   1196             full_backward_hooks, non_full_backward_hooks = [], []

/usr/local/lib/python3.9/dist-packages/transformers/models/bart/modeli
ng_bart.py in forward(self, input_ids, attention_mask,
decoder_input_ids, decoder_attention_mask, head_mask,
decoder_head_mask, cross_attn_head_mask, encoder_outputs,
past_key_values, inputs_embeds, decoder_inputs_embeds, use_cache,
output_attentions, output_hidden_states, return_dict)
   1254
   1255             # decoder outputs consists of (dec_features,
```

```
              past_key_value, dec_hidden, dec_attn)
-> 1256           decoder_outputs = self.decoder(
   1257               input_ids=decoder_input_ids,
   1258               attention_mask=decoder_attention_mask,
```

/usr/local/lib/python3.9/dist-packages/torch/nn/modules/module.py in
_call_impl(self, *input, **kwargs)
```
   1192       if not (self._backward_hooks or self._forward_hooks or
self._forward_pre_hooks or _global_backward_hooks
   1193               or _global_forward_hooks or
_global_forward_pre_hooks):
-> 1194           return forward_call(*input, **kwargs)
   1195       # Do not call functions when jit is used
   1196       full_backward_hooks, non_full_backward_hooks = [], []
```

/usr/local/lib/python3.9/dist-packages/transformers/models/bart/modeli
ng_bart.py in forward(self, input_ids, attention_mask,
encoder_hidden_states, encoder_attention_mask, head_mask,
cross_attn_head_mask, past_key_values, inputs_embeds, use_cache,
output_attentions, output_hidden_states, return_dict)
```
   1111           else:
   1112
-> 1113               layer_outputs = decoder_layer(
   1114                   hidden_states,
   1115                   attention_mask=attention_mask,
```

/usr/local/lib/python3.9/dist-packages/torch/nn/modules/module.py in
_call_impl(self, *input, **kwargs)
```
   1192       if not (self._backward_hooks or self._forward_hooks or
self._forward_pre_hooks or _global_backward_hooks
   1193               or _global_forward_hooks or
_global_forward_pre_hooks):
-> 1194           return forward_call(*input, **kwargs)
   1195       # Do not call functions when jit is used
   1196       full_backward_hooks, non_full_backward_hooks = [], []
```

/usr/local/lib/python3.9/dist-packages/transformers/models/bart/modeli
ng_bart.py in forward(self, hidden_states, attention_mask,
encoder_hidden_states, encoder_attention_mask, layer_head_mask,
cross_attn_layer_head_mask, past_key_value, output_attentions,
use_cache)
```
    443               # cross_attn cached key/values tuple is at
positions 3,4 of present_key_value tuple
    444               cross_attn_past_key_value = past_key_value[-2:] if
past_key_value is not None else None
--> 445               hidden_states, cross_attn_weights,
cross_attn_present_key_value = self.encoder_attn(
    446                   hidden_states=hidden_states,
    447                   key_value_states=encoder_hidden_states,
```

```
/usr/local/lib/python3.9/dist-packages/torch/nn/modules/module.py in
_call_impl(self, *input, **kwargs)
   1192         if not (self._backward_hooks or self._forward_hooks or
self._forward_pre_hooks or _global_backward_hooks
   1193                 or _global_forward_hooks or
_global_forward_pre_hooks):
-> 1194             return forward_call(*input, **kwargs)
   1195         # Do not call functions when jit is used
   1196         full_backward_hooks, non_full_backward_hooks = [], []

/usr/local/lib/python3.9/dist-packages/transformers/models/bart/modeli
ng_bart.py in forward(self, hidden_states, key_value_states,
past_key_value, attention_mask, layer_head_mask, output_attentions)
    288         attn_output = attn_output.reshape(bsz, tgt_len,
self.embed_dim)
    289
--> 290         attn_output = self.out_proj(attn_output)
    291
    292         return attn_output, attn_weights_reshaped,
past_key_value

/usr/local/lib/python3.9/dist-packages/torch/nn/modules/module.py in
_call_impl(self, *input, **kwargs)
   1192         if not (self._backward_hooks or self._forward_hooks or
self._forward_pre_hooks or _global_backward_hooks
   1193                 or _global_forward_hooks or
_global_forward_pre_hooks):
-> 1194             return forward_call(*input, **kwargs)
   1195         # Do not call functions when jit is used
   1196         full_backward_hooks, non_full_backward_hooks = [], []

/usr/local/lib/python3.9/dist-packages/torch/nn/modules/linear.py in
forward(self, input)
    112
    113     def forward(self, input: Tensor) -> Tensor:
--> 114         return F.linear(input, self.weight, self.bias)
    115
    116     def extra_repr(self) -> str:

KeyboardInterrupt:
```

Failed Attempt 2:

Tried a for loop to itterate through the possible_emotion row by row and picking the emotion with the highest probability score Failed due to a 0% on Kaggle wrong predictions

```
from transformers import pipeline
import pandas as pd
import ast
```

```python
# Loading the zero-shot classification pipeline
# Using the classifier to predict the most likely emotion for each row
and possible emotion
# Model: twitter-roberta-base-emotion
classifier = pipeline("text-classification",
model="cardiffnlp/twitter-roberta-base-emotion")


predicted_emotions = []
for i, row in df_test.iterrows():
    text = row["text"]
    possible_emotions = ast.literal_eval(row["possible_emotions"])
    max_score = -1
    predicted_emotion = ""
    for emotion in possible_emotions:
        result = classifier(text, [emotion])
        if result[0]["score"] > max_score:
            max_score = result[0]["score"]
            predicted_emotion = emotion
    predicted_emotions.append(predicted_emotion)

# Add the predicted emotions to the test dataframe
df_test["predicted_emotions"] = predicted_emotions

# Save the results to a CSV file
df_test.to_csv('predictions3.csv', index=False)

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df_pred2 = pd.read_csv('/content/predictions3.csv')
df_pred2.drop("possible_emotions", axis =1, inplace = True)
df_pred2.drop("text", axis=1, inplace = True)
df_pred2 = df_pred2.rename(columns={'predicted_emotions': 'labels'})
df_pred2.to_csv('predictions6.csv', index=False)

display(df_pred2)

      index        labels
0         0         alarm
1         1         shock
2         2         panic
3         3    attachment
4         4    tenderness
...     ...           ...
1995   1995    jubilation
1996   1996         alarm
1997   1997        sorrow
1998   1998    depression
1999   1999         shock

[2000 rows x 2 columns]
```

Successful Attempt 3:

Used roberta-large-mnli a much larger pretrained model and looped through the possible_emotion row by row and picking the emotion with the highest probability score Succeeded with 0.364% score on Kaggle

```python
from transformers import pipeline
import pandas as pd
import ast

# Loading the zero-shot classification pipeline using the mode
# roberta-large-mnli
classifier = pipeline("zero-shot-classification", model="roberta-large-mnli")

predicted_emotions = []
for i, row in df_test.iterrows():
    text = row["text"]
    possible_emotions = ast.literal_eval(row["possible_emotions"])
    max_score = -1
    predicted_emotion = ""
    for emotion in possible_emotions:
        result = classifier(text, emotion)
        if result["scores"][0] > max_score:
            max_score = result["scores"][0]
            predicted_emotion = result["labels"][0]
    predicted_emotions.append(predicted_emotion)

# Add the predicted emotions to the test dataframe
df_test["predicted_emotions"] = predicted_emotions

# Save the results to a CSV file
df_test.to_csv('predictions7.csv', index=False)
```

{"model_id":"cb2ea3c101594404a4c271b68d97e70a","version_major":2,"version_minor":0}

{"model_id":"c7acfabde4c04d1594f101699a70f617","version_major":2,"version_minor":0}

```
Some weights of the model checkpoint at roberta-large-mnli were not
used when initializing RobertaForSequenceClassification:
['roberta.pooler.dense.weight', 'roberta.pooler.dense.bias']
- This IS expected if you are initializing
RobertaForSequenceClassification from the checkpoint of a model
trained on another task or with another architecture (e.g.
initializing a BertForSequenceClassification model from a
BertForPreTraining model).
- This IS NOT expected if you are initializing
RobertaForSequenceClassification from the checkpoint of a model that
you expect to be exactly identical (initializing a
```

BertForSequenceClassification model from a
BertForSequenceClassification model).

{"model_id":"d2590cf9000248939a88203485ecf403","version_major":2,"version_minor":0}

{"model_id":"8eaa7588b11e43669cf1e03d3909bf7e","version_major":2,"version_minor":0}

{"model_id":"608bbcbdd5624b9882c917f96112b961","version_major":2,"version_minor":0}

```
df_pred5 = pd.read_csv('predictions7.csv')
df_pred5.drop("possible_emotions", axis =1, inplace = True)
df_pred5.drop("text", axis=1, inplace = True)
df_pred5 = df_pred5.rename(columns={'predicted_emotions': 'labels'})
df_pred5.to_csv('predictions7.csv', index=False)
df_pred5
```

```
        index            labels
0           0      exasperation
1           1            sorrow
2           2            regret
3           3          intimacy
4           4       unhappiness
...       ...               ...
1995     1995         annoyance
1996     1996          vexation
1997     1997           triumph
1998     1998            warmth
1999     1999          vexation

[2000 rows x 2 columns]
```

Unsure Attempt 4:

Used t5 large a much larger pretrained model and looped through the possible_emotion
row by row and picking the emotion with the highest probability score. Unable to verify
until I restart the kernel

```
!pip install sentencepiece
```

```
Looking in indexes: https://pypi.org/simple, https://us-
python.pkg.dev/colab-wheels/public/simple/
Collecting sentencepiece
  Downloading sentencepiece-0.1.97-cp39-cp39-
manylinux_2_17_x86_64.manylinux2014_x86_64.whl (1.3 MB)
━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 1.3/1.3 MB 17.9 MB/s eta
0:00:00
```

```
from transformers import T5ForConditionalGeneration, T5Tokenizer
```

```python
model = T5ForConditionalGeneration.from_pretrained("t5-large")
tokenizer = T5Tokenizer.from_pretrained("t5-large")

predicted_emotions = []

for i, row in df_test.iterrows():
    text = row["text"]
    possible_emotions = ast.literal_eval(row["possible_emotions"])
    input_text = "classify emotions: {} to {}".format(text,
possible_emotions)
    input_ids = tokenizer.encode(input_text, return_tensors="pt")
    output = model.generate(input_ids)
    predicted_emotion = tokenizer.decode(output[0],
skip_special_tokens=True)
    predicted_emotions.append(predicted_emotion)

# Add the predicted emotions to the test dataframe
df_test["predicted_emotions"] = predicted_emotions

# Save the results to a CSV file
df_test.to_csv('predictions8.csv', index=False)

-----------------------------------------------------------------------
-----
TypeError                                 Traceback (most recent call
last)
<ipython-input-39-3636be12d252> in <module>
      2
      3 model = T5ForConditionalGeneration.from_pretrained("t5-large")
----> 4 tokenizer = T5Tokenizer.from_pretrained("t5-large")
      5
      6 predicted_emotions = []

TypeError: 'NoneType' object is not callable

df_pred8 = pd.read_csv('predictions8.csv')
df_pred8
```

Unsure Attempt 5:

Used GPT-2 a much larger pretrained model and looped through the possible_emotion row by row and picking the emotion with the highest probability score. Computationally Expensive and the run time is extermely long almost 2 hours Kaggle Score: 0.0755%

```python
from transformers import pipeline

# load the zero-shot classification pipeline with GPT-2 as the model
classifier = pipeline("zero-shot-classification",
model="EleutherAI/gpt-neo-2.7B")
predicted_emotions = []
```

```python
for i, row in df_test.iterrows():
    text = row["text"]
    possible_emotions = ast.literal_eval(row["possible_emotions"])
    max_score = -1
    predicted_emotion = ""
    for emotion in possible_emotions:
        result = classifier(text, emotion)
        if result["scores"][0] > max_score:
            max_score = result["scores"][0]
            predicted_emotion = result["labels"][0]
    predicted_emotions.append(predicted_emotion)

# Add the predicted emotions to the test dataframe
df_test["predicted_emotions"] = predicted_emotions

# Save the results to a CSV file
df_test.to_csv('predictions9.csv', index=False)
```

{"model_id":"148056bf30a04e1f9df469dcccc04d9f","version_major":2,"version_minor":0}

{"model_id":"0c0f6ddd13e845e3aa66988856e20655","version_major":2,"version_minor":0}

Some weights of GPTNeoForSequenceClassification were not initialized from the model checkpoint at EleutherAI/gpt-neo-2.7B and are newly initialized: ['transformer.h.25.attn.attention.bias', 'transformer.h.21.attn.attention.bias', 'transformer.h.19.attn.attention.bias', 'transformer.h.15.attn.attention.bias', 'transformer.h.9.attn.attention.bias', 'transformer.h.13.attn.attention.bias', 'transformer.h.27.attn.attention.bias', 'transformer.h.3.attn.attention.bias', 'transformer.h.17.attn.attention.bias', 'transformer.h.7.attn.attention.bias', 'transformer.h.1.attn.attention.bias', 'transformer.h.29.attn.attention.bias', 'transformer.h.31.attn.attention.bias', 'transformer.h.5.attn.attention.bias', 'transformer.h.23.attn.attention.bias', 'transformer.h.11.attn.attention.bias', 'score.weight']
You should probably TRAIN this model on a down-stream task to be able to use it for predictions and inference.

{"model_id":"d12ae5223e0d446f94abd00adf98308f","version_major":2,"version_minor":0}

{"model_id":"4f8323f938b3491b9cede83ab5595cab","version_major":2,"version_minor":0}

{"model_id":"b5f21ff690354dd5aa335c9d07feb8df","version_major":2,"version_minor":0}

{"model_id":"c482f913daf9433ca0184754f2381249","version_major":2,"version_minor":0}

```
Failed to determine 'entailment' label id from the label2id mapping in
the model config. Setting to -1. Define a descriptive label2id mapping
in the model config to ensure correct outputs.
Using pad_token, but it is not set yet.
Tokenizer was not supporting padding necessary for zero-shot,
attempting to use  `pad_token=eos_token`
```

```python
df_pred9 = pd.read_csv('predictions9.csv')
df_pred9
```

```
      index                                               text  \
0         0  im feeling rather rotten so im not very ambiti...
1         1              im updating my blog because i feel shitty
2         2  i never make her separate from me because i do...
3         3  i left with my bouquet of red and yellow tulip...
4         4    i was feeling a little vain when i did this one
...     ...                                                ...
1995   1995  i just keep feeling like someone is being unki...
1996   1996  im feeling a little cranky negative after this...
1997   1997  i feel that i am useful to my people and that ...
1998   1998  im feeling more comfortable with derby i feel ...
1999   1999  i feel all weird when i have to meet w people ...

                                    possible_emotions
predicted_emotions
0       ['alarm', 'exasperation', 'terror', 'tendernes...
exasperation
1       ['shock', 'jubilation', 'shock', 'fright', 'fr...
tenderness
2       ['panic', 'shock', 'exultation', 'fright', 'jo...
regret
3       ['attachment', 'annoyance', 'exasperation', 'i...
intimacy
4       ['tenderness', 'tenderness', 'exultation', 'tr...
intimacy
...                                                 ...
...
1995  ['jubilation', 'fondness', 'depression', 'stag...
warmth
1996  ['alarm', 'warmth', 'tenderness', 'depression'...
warmth
1997  ['sorrow', 'fright', 'intimacy', 'stun', 'depr...
intimacy
1998  ['depression', 'stun', 'warmth', 'annoyance', ...
horror
```

```
1999  ['shock', 'vexation', 'warmth', 'unhappiness',...
warmth

[2000 rows x 4 columns]


df_pred9.drop("possible_emotions", axis =1, inplace = True)
df_pred9.drop("text", axis=1, inplace = True)
df_pred9 = df_pred9.rename(columns={'predicted_emotions': 'labels'})
df_pred9.to_csv('predictions9.csv', index=False)
df_pred9

       index        labels
0          0  exasperation
1          1    tenderness
2          2        regret
3          3      intimacy
4          4      intimacy
...      ...           ...
1995    1995        warmth
1996    1996        warmth
1997    1997      intimacy
1998    1998        horror
1999    1999        warmth

[2000 rows x 2 columns]
```

Exercise 5 (Dealing with Overfit)

```python
def undersampsRand(data):
    df0 = data[data['label'] == 0]
    df1 = data[data['label'] == 1]
    df2 = data[data['label'] == 2]
    df3 = data[data['label'] == 3]
    df4 = data[data['label'] == 4]
    df5 = data[data['label'] == 5]

    df0 = df0.sample(n = 500, replace = True)
    df1 = df1.sample(n = 500, replace = True)
    df2 = df2.sample(n = 500, replace = True)
    df3 = df3.sample(n = 500, replace = True)
    df4 = df4.sample(n = 500, replace = True)
    df5 = df5.sample(n = 500, replace = True)

    return pd.concat([df0, df1, df2, df3, df4, df5], axis = 0)
```

Logistic Regression

```python
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
```

```python
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.metrics import accuracy_score, classification_report,
confusion_matrix, precision_score, recall_score, f1_score,
roc_auc_score
from sklearn.metrics import precision_recall_curve

def tokenize(df):
    # CountVectorizer object to tokenize the tweets
    # from the 'text' column
    # fitting it to the 'text' column
    cv = CountVectorizer()
    # Converting the 'text' from object to string
    df['text'] = df['text'].astype(str)
    cv.fit(df['text'])

    tokenized = cv.transform(df['text'])

    # Return a list of tokenized tweets.
    return tokenized


# Tokenize the tweets
df =
pd.read_csv('/content/drive/MyDrive/Intro2AdvancedML/TwitterSentimentP
roject/TwitterSentiment.csv')
test_df =
pd.read_csv('/content/drive/MyDrive/Intro2AdvancedML/TwitterSentimentP
roject/Kaggle1Sentiment.csv')
#---------------------------------------------------------------------
------#
#Undersample
df = undersampsRand(df)
#_-------------------------------------------------------------------
-------#
tokenized_df = tokenize(df)

# To test the model on a tokenized test dataset
tokenized_kaggle = tokenize(test_df)

#
https://scikit-learn.org/stable/modules/generated/sklearn.preprocessin
g.LabelBinarizer.html
from sklearn.preprocessing import LabelBinarizer

def LR(df, max_iter=2000):
    X = tokenized_df
    y = df['label']
#--------------------------------------------------------------------
----#
```

```python
# Train Test Split using the fitting with Logistic Regression
    X_train, X_test, y_train, y_test = train_test_split(X, y,
test_size=0.2, random_state=42)
    lr = LogisticRegression()
    lr.fit(X_train, y_train)
#-----------------------------------------------------------------------
----#
    y_pred = lr.predict(X_test)
    lb = LabelBinarizer()
    lb.fit(y_test)
    test_labels = lb.transform(y_test)
    test_predictions = lb.transform(y_pred)
#-----------------------------------------------------------------------
----#
    accuracy = accuracy_score(y_test, y_pred)
    precision_macro = precision_score(y_test, y_pred, average='macro')
    recall_macro = recall_score(y_test, y_pred, average='macro')
    f1_macro = f1_score(y_test, y_pred, average='macro')
    auc_macro = roc_auc_score(test_labels, test_predictions,
average='macro', multi_class='ovo')
#-----------------------------------------------------------------------
----#
    print('Accuracy:', accuracy)
    print(classification_report(y_test, y_pred))
    print()
    print('Confusion Matrix: \n')
    cf_matrix = confusion_matrix(y_test, y_pred)
    cm_display = ConfusionMatrixDisplay(confusion_matrix=cf_matrix,
display_labels = ['Sadness', 'Joy', 'Love', 'Anger', 'Fear',
'Surprise'])
    cm_display.plot()
    plt.show()

    print()
    print('Macro Precision:', precision_macro)
    print('Macro Recall:', recall_macro)
    print('Macro F1-score:', f1_macro)
    print('Macro AUC:', auc_macro)

LR(df, max_iter=2000)

/usr/local/lib/python3.9/dist-packages/sklearn/linear_model/
_logistic.py:458: ConvergenceWarning: lbfgs failed to converge
(status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as
shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
```

https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(

Accuracy: 0.7516666666666667
               precision   recall f1-score   support

           0   0.73   0.61   0.67   118
           1   0.57   0.61   0.59   99
           2   0.80   0.82   0.81   96
           3   0.82   0.78   0.80   101
           4   0.71   0.80   0.75   91
           5   0.90   0.93   0.91   95

    accuracy   0.75   600
   macro avg   0.75   0.76   0.75   600
weighted avg   0.75   0.75   0.75   600

Confusion Matrix:
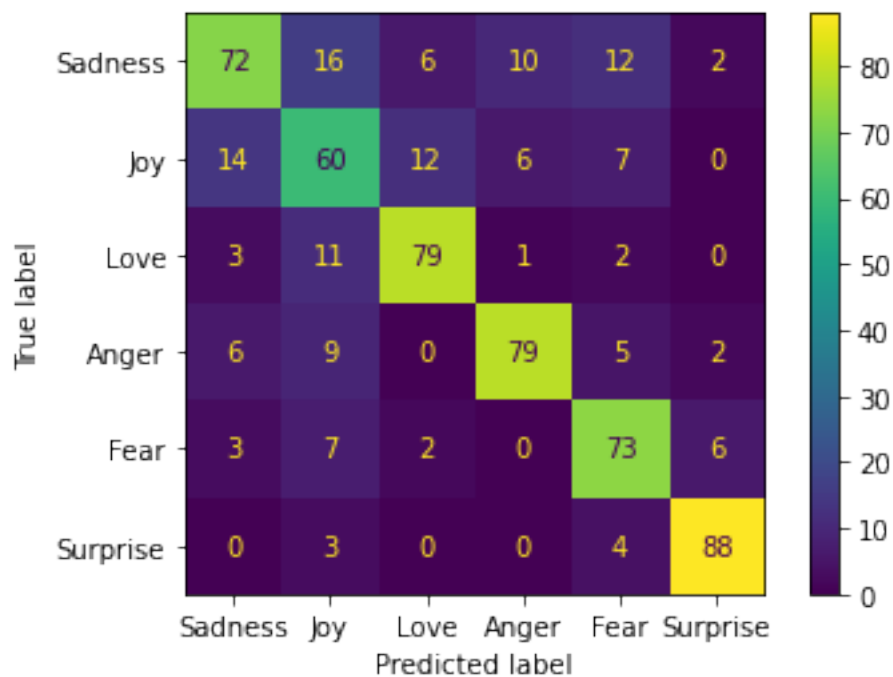
Macro Precision: 0.7547208542996134
Macro Recall: 0.7583064289576608
Macro F1-score: 0.7548023009112717
Macro AUC: 0.8542990454455425

LSTM

```python
import pandas as pd
import numpy as np
from keras.preprocessing.text import Tokenizer
from keras.models import Sequential
from keras.layers import Embedding, LSTM, Dense

#-------------------------------------------------------------------------
----------#
# Tokenizer: https://keras.io/api/preprocessing/text/
# Sequential model: https://keras.io/api/models/sequential/
# Embedding layer: https://keras.io/api/layers/core_layers/embedding/
# LSTM layer: https://keras.io/api/layers/recurrent_layers/lstm/
# Dense layer: https://keras.io/api/layers/core_layers/dense/
# compile method:
https://keras.io/api/models/model_training_apis/#compile-method
# fit method: https://keras.io/api/models/model_training_apis/#fit-
method
# pad_sequences function:
https://keras.io/api/preprocessing/timeseries/#pad_sequences-function
#-------------------------------------------------------------------------
----------#
# load the training dataset
train_data =
pd.read_csv('/content/drive/MyDrive/Intro2AdvancedML/TwitterSentimentP
roject/TwitterSentiment.csv')
#-------------------------------------------------------------------------
------#
#Undersample
train_data = undersampsRand(train_data)
#-------------------------------------------------------------------------
----------#
# tokenize the text data
tokenizer = Tokenizer()
tokenizer.fit_on_texts(train_data['text'])
train_seq = tokenizer.texts_to_sequences(train_data['text'])
train_pad_seq = pad_sequences(train_seq, maxlen=50, padding='post')
#-------------------------------------------------------------------------
----------#
# create one-hot-encoded labels
train_labels = pd.get_dummies(train_data['label']).values
#-------------------------------------------------------------------------
----------#
X_train, X_test, y_train, y_test = train_test_split(train_pad_seq,
train_labels, test_size=0.2, random_state=42)
```

```python
X_val, X_test, y_val, y_test = train_test_split(X_test, y_test,
test_size=0.5, random_state=42)
#-----------------------------------------------------------------
---------#
# define the LSTM model
model = Sequential()
model.add(Embedding(len(tokenizer.word_index)+1, 32, input_length=50))
model.add(LSTM(64))
model.add(Dense(6, activation='softmax'))
#-----------------------------------------------------------------
---------#
# compile the model
model.compile(optimizer='adam', loss='categorical_crossentropy',
metrics=['accuracy'])
#-----------------------------------------------------------------
---------#
# train the model
history = model.fit(X_train, y_train, validation_data = (X_val,
y_val), epochs=30, batch_size=64)
#-----------------------------------------------------------------
---------#
# Test Set
pred = model.predict(X_test)
test_pred_labels = np.argmax(pred, axis=1)
y_test = pd.DataFrame(y_test).idxmax(axis=1)

print(classification_report(y_test, test_pred_labels))
print()
print('Confusion Matrix: \n')
cf_matrix = confusion_matrix(y_test, test_pred_labels)
cm_display = ConfusionMatrixDisplay(confusion_matrix=cf_matrix,
display_labels = ['Sadness', 'Joy', 'Love', 'Anger', 'Fear',
'Surprise'])
cm_display.plot()
plt.show()

print('Precision = ', precision_score(y_test, test_pred_labels,
average='macro'))
print('Recall = ', recall_score(y_test, test_pred_labels,
average='macro'))
print('F1 Score = ', f1_score(y_test, test_pred_labels,
average='macro'))

Epoch 1/30
38/38 [==============================] - 4s 41ms/step - loss: 1.7935 -
accuracy: 0.1596 - val_loss: 1.7974 - val_accuracy: 0.1500
Epoch 2/30
38/38 [==============================] - 1s 26ms/step - loss: 1.7923 -
accuracy: 0.1683 - val_loss: 1.7929 - val_accuracy: 0.1667
Epoch 3/30
```

```
38/38 [==============================] - 1s 27ms/step - loss: 1.7918 -
accuracy: 0.1708 - val_loss: 1.7946 - val_accuracy: 0.1533
Epoch 4/30
38/38 [==============================] - 1s 27ms/step - loss: 1.7855 -
accuracy: 0.1908 - val_loss: 1.7735 - val_accuracy: 0.2300
Epoch 5/30
38/38 [==============================] - 1s 28ms/step - loss: 1.5822 -
accuracy: 0.2983 - val_loss: 1.5092 - val_accuracy: 0.2600
Epoch 6/30
38/38 [==============================] - 1s 27ms/step - loss: 1.2770 -
accuracy: 0.3762 - val_loss: 1.4760 - val_accuracy: 0.3767
Epoch 7/30
38/38 [==============================] - 1s 27ms/step - loss: 1.1104 -
accuracy: 0.4629 - val_loss: 1.4829 - val_accuracy: 0.3800
Epoch 8/30
38/38 [==============================] - 1s 27ms/step - loss: 0.9336 -
accuracy: 0.5633 - val_loss: 1.5272 - val_accuracy: 0.4433
Epoch 9/30
38/38 [==============================] - 1s 27ms/step - loss: 0.7943 -
accuracy: 0.6333 - val_loss: 1.4631 - val_accuracy: 0.5100
Epoch 10/30
38/38 [==============================] - 1s 28ms/step - loss: 0.5918 -
accuracy: 0.7437 - val_loss: 1.4751 - val_accuracy: 0.5367
Epoch 11/30
38/38 [==============================] - 1s 28ms/step - loss: 0.4510 -
accuracy: 0.7925 - val_loss: 1.4276 - val_accuracy: 0.5633
Epoch 12/30
38/38 [==============================] - 1s 28ms/step - loss: 0.3860 -
accuracy: 0.8358 - val_loss: 1.5294 - val_accuracy: 0.5533
Epoch 13/30
38/38 [==============================] - 1s 28ms/step - loss: 0.3215 -
accuracy: 0.8662 - val_loss: 1.4285 - val_accuracy: 0.6067
Epoch 14/30
38/38 [==============================] - 1s 27ms/step - loss: 0.2326 -
accuracy: 0.9242 - val_loss: 1.5844 - val_accuracy: 0.6000
Epoch 15/30
38/38 [==============================] - 1s 28ms/step - loss: 0.1755 -
accuracy: 0.9450 - val_loss: 1.6686 - val_accuracy: 0.6300
Epoch 16/30
38/38 [==============================] - 1s 28ms/step - loss: 0.1494 -
accuracy: 0.9588 - val_loss: 1.6543 - val_accuracy: 0.6333
Epoch 17/30
38/38 [==============================] - 1s 27ms/step - loss: 0.1373 -
accuracy: 0.9638 - val_loss: 1.7327 - val_accuracy: 0.6300
Epoch 18/30
38/38 [==============================] - 1s 27ms/step - loss: 0.1336 -
accuracy: 0.9596 - val_loss: 1.7380 - val_accuracy: 0.6000
Epoch 19/30
38/38 [==============================] - 1s 27ms/step - loss: 0.1245 -
accuracy: 0.9650 - val_loss: 1.7667 - val_accuracy: 0.6300
```

```
Epoch 20/30
38/38 [==============================] - 1s 27ms/step - loss: 0.1319 -
accuracy: 0.9658 - val_loss: 1.7227 - val_accuracy: 0.6367
Epoch 21/30
38/38 [==============================] - 1s 30ms/step - loss: 0.0759 -
accuracy: 0.9829 - val_loss: 1.7340 - val_accuracy: 0.6367
Epoch 22/30
38/38 [==============================] - 1s 30ms/step - loss: 0.0819 -
accuracy: 0.9787 - val_loss: 1.9295 - val_accuracy: 0.6067
Epoch 23/30
38/38 [==============================] - 1s 29ms/step - loss: 0.0666 -
accuracy: 0.9846 - val_loss: 1.8853 - val_accuracy: 0.6333
Epoch 24/30
38/38 [==============================] - 1s 29ms/step - loss: 0.0589 -
accuracy: 0.9854 - val_loss: 1.8117 - val_accuracy: 0.6600
Epoch 25/30
38/38 [==============================] - 1s 28ms/step - loss: 0.0512 -
accuracy: 0.9883 - val_loss: 1.9812 - val_accuracy: 0.6367
Epoch 26/30
38/38 [==============================] - 1s 28ms/step - loss: 0.0924 -
accuracy: 0.9771 - val_loss: 1.9826 - val_accuracy: 0.6400
Epoch 27/30
38/38 [==============================] - 1s 28ms/step - loss: 0.0412 -
accuracy: 0.9912 - val_loss: 2.0187 - val_accuracy: 0.6500
Epoch 28/30
38/38 [==============================] - 1s 28ms/step - loss: 0.0320 -
accuracy: 0.9937 - val_loss: 2.0131 - val_accuracy: 0.6500
Epoch 29/30
38/38 [==============================] - 1s 28ms/step - loss: 0.0654 -
accuracy: 0.9829 - val_loss: 2.1839 - val_accuracy: 0.6300
Epoch 30/30
38/38 [==============================] - 1s 28ms/step - loss: 0.0574 -
accuracy: 0.9867 - val_loss: 2.0693 - val_accuracy: 0.6433
10/10 [==============================] - 0s 7ms/step
              precision    recall  f1-score   support

           0       0.57      0.48      0.52        52
           1       0.62      0.41      0.49        51
           2       0.73      0.75      0.74        51
           3       0.43      0.60      0.50        47
           4       0.56      0.70      0.62        50
           5       0.86      0.73      0.79        49

    accuracy                           0.61       300
   macro avg       0.63      0.61      0.61       300
weighted avg       0.63      0.61      0.61       300


Confusion Matrix:
```
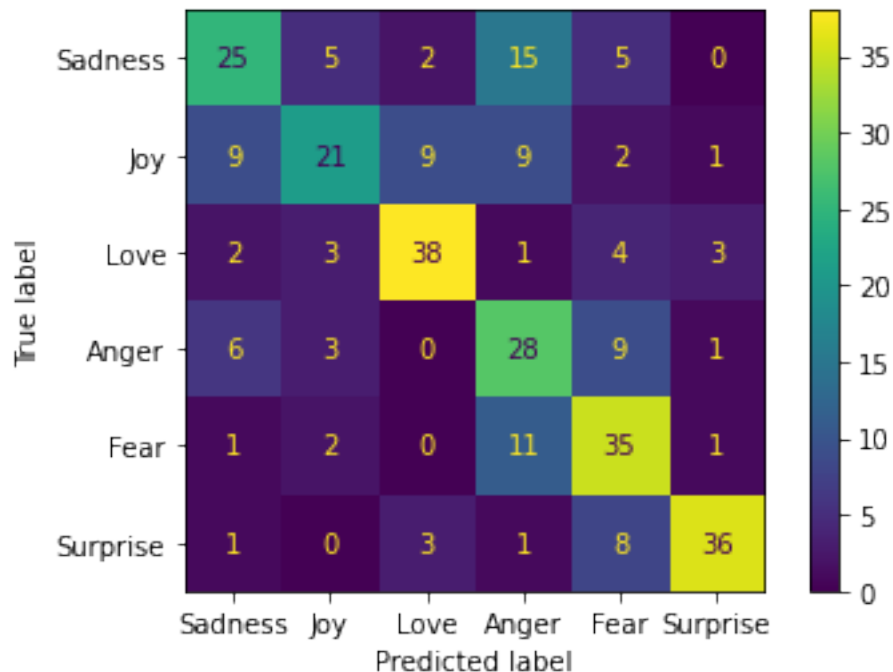
```
Precision =  0.626677625207037
Recall =  0.6113450890448924
F1 Score =  0.6105821459699207
```

```python
#--------------------------------------------------------------------
---------#
# load the test dataset
test_data =
pd.read_csv('/content/drive/MyDrive/Intro2AdvancedML/TwitterSentimentP
roject/Kaggle1Sentiment.csv')
#--------------------------------------------------------------------
---------#
# tokenize and pad the text data
test_seq = tokenizer.texts_to_sequences(test_data['text'])
test_pad_seq = pad_sequences(test_seq, maxlen=50, padding='post')
#--------------------------------------------------------------------
---------#
# make predictions on test data
test_pred = model.predict(test_pad_seq)
#--------------------------------------------------------------------
---------#
# save the predictions to a csv file
test_pred_labels = np.argmax(test_pred, axis=1)
test_data['label'] = test_pred_labels
test_data.to_csv('test_pred.csv', index=False)
```

```
63/63 [==============================] - 0s 7ms/step
```
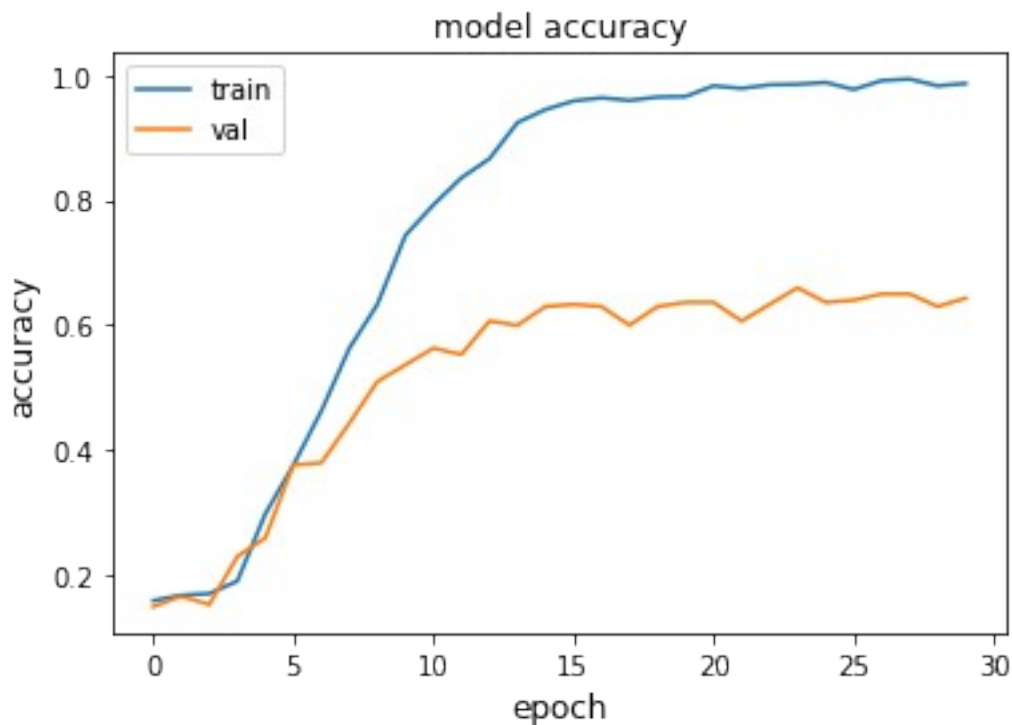
```python
def plotting_nn():
  metric = "accuracy"
```

```python
    plt.figure()
    plt.plot(history.history[metric])
    plt.plot(history.history["val_" + metric])
    plt.title("model " + metric)
    plt.ylabel(metric, fontsize="large")
    plt.xlabel("epoch", fontsize="large")
    plt.legend(["train", "val"], loc="best")
    return plt.show()

plotting_nn()
```


Transformer

```python
from sklearn.metrics import classification_report, confusion_matrix,
accuracy_score
from transformers import pipeline
import pandas as pd
#
https://huggingface.co/docs/transformers/main_classes/pipelines#transf
ormers.pipeline
#
https://scikit-learn.org/stable/modules/generated/sklearn.metrics.clas
sification_report.html
#
https://scikit-learn.org/stable/modules/generated/sklearn.metrics.conf
usion_matrix.html
```

```python
classifier = pipeline("text-classification",
                      model='bhadresh-savani/distilbert-base-uncased-
emotion',
                      tokenizer='distilbert-base-uncased')
# ---------------------------------------------------------------------#
def transformer(df):

    # Applying it to the Text Column
    emotions = df['text'].apply(classifier)
# ---------------------------------------------------------------------#
    # Extract the predicted emotion labels and scores
    predicted_emotions = emotions.apply(lambda x: x[0]['label'])
    predicted_scores = emotions.apply(lambda x: x[0]['score'])
# ---------------------------------------------------------------------#
    # Combine the predicted emotion labels and scores into a dataframe
    df_predicted = pd.DataFrame({'text': df['text'],
                                 'predicted_emotion':
predicted_emotions,
                                 'predicted_score': predicted_scores})
    return df_predicted
# ---------------------------------------------------------------------#
# The Datasets
labelinfo = {'sadness': 0, 'joy': 1, 'love': 2, 'anger': 3, 'fear': 4,
'surprise': 5}
train_df =
pd.read_csv('/content/drive/MyDrive/Intro2AdvancedML/TwitterSentimentP
roject/TwitterSentiment.csv')
#---------------------------------------------------------------------
--------#
#Undersample
train_df = undersampsRand(train_df)
#---------------------------------------------------------------------
--------#
for i, num in enumerate(train_df['label']):
  for j in labelinfo:
    if labelinfo[j] == num:
      train_df['label'].loc[train_df.index[i]] = j

test_df =
pd.read_csv('/content/drive/MyDrive/Intro2AdvancedML/TwitterSentimentP
roject/Kaggle1Sentiment.csv')
# ---------------------------------------------------------------------#
X_train, X_test, y_train, y_test = train_test_split(train_df['text'],
train_df['label'], test_size=0.2, random_state=42)
X_val, X_test, y_val, y_test = train_test_split(X_test, y_test,
test_size=0.5, random_state=42)
#---------------------------------------------------------------------#

<ipython-input-92-9a7ee2933473>:36: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame
```

```
See the caveats in the documentation:
https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#
returning-a-view-versus-a-copy
  train_df['label'].loc[train_df.index[i]] = j

# Transform the datasets
# ------------------------------------------------------------------#
temp =  X_train.apply(classifier)
train_pred = temp.apply(lambda x: x[0]['label'])

temp = X_val.apply(classifier)
val_pred = temp.apply(lambda x: x[0]['label'])

temp = X_test.apply(classifier)
test_pred = temp.apply(lambda x: x[0]['label'])

train_df_transformed = transformer(train_df)
kaggle_df_transformed = transformer(test_df)
# ------------------------------------------------------------------#
# Metrics
def MetricReport(truth, pred):
  print("Training Classification Report: ")

  print(classification_report(truth,
                              pred,
                              zero_division=1))

  print("\nTraining Confusion Matrix: ")
  cf_matrix = confusion_matrix(truth, pred)
  cm_display = ConfusionMatrixDisplay(confusion_matrix=cf_matrix,
display_labels = ['Sadness', 'Joy', 'Love', 'Anger', 'Fear',
'Surprise'])
  cm_display.plot()
  plt.show()

  print('Accuracy = ', accuracy_score(truth, pred))
  print('Precision = ', precision_score(truth, pred, average='macro'))
  print('Recall = ', recall_score(truth, pred, average='macro'))
  print('F1 Score = ', f1_score(truth, pred, average='macro'))

print('Training')
MetricReport(y_train, train_pred)
print()
print('Validation')
MetricReport(y_val, val_pred)
print()
print('Test')
MetricReport(y_test, test_pred)
```
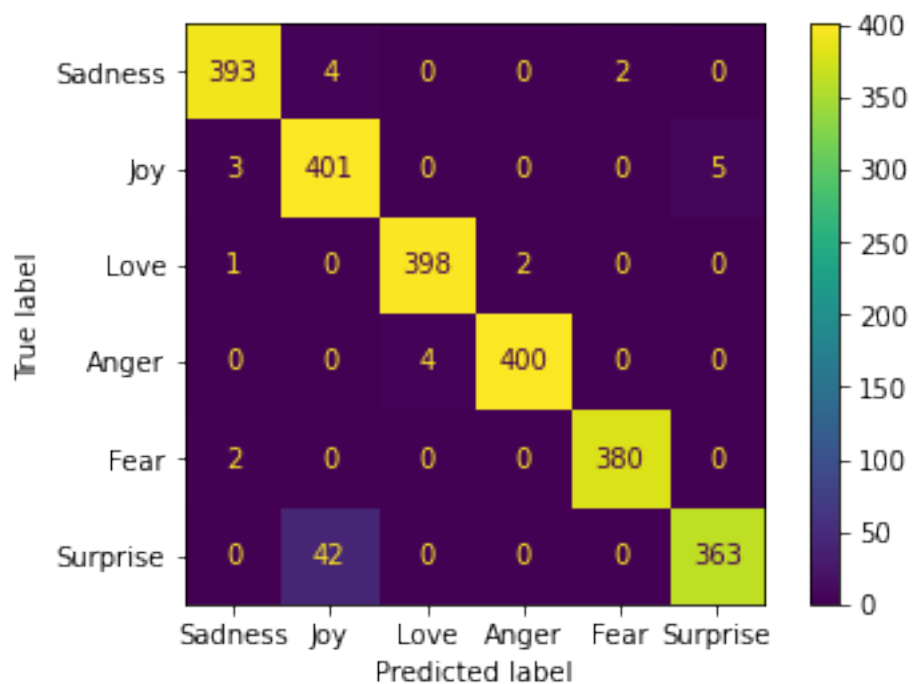
Training
Training Classification Report:

	precision	recall	f1-score	support
anger	0.98	0.98	0.98	399
fear	0.90	0.98	0.94	409
joy	0.99	0.99	0.99	401
love	1.00	0.99	0.99	404
sadness	0.99	0.99	0.99	382
surprise	0.99	0.90	0.94	405
accuracy			0.97	2400
macro avg	0.97	0.97	0.97	2400
weighted avg	0.97	0.97	0.97	2400

Training Confusion Matrix:

Accuracy = 0.9729166666666667
Precision = 0.9747176994766346
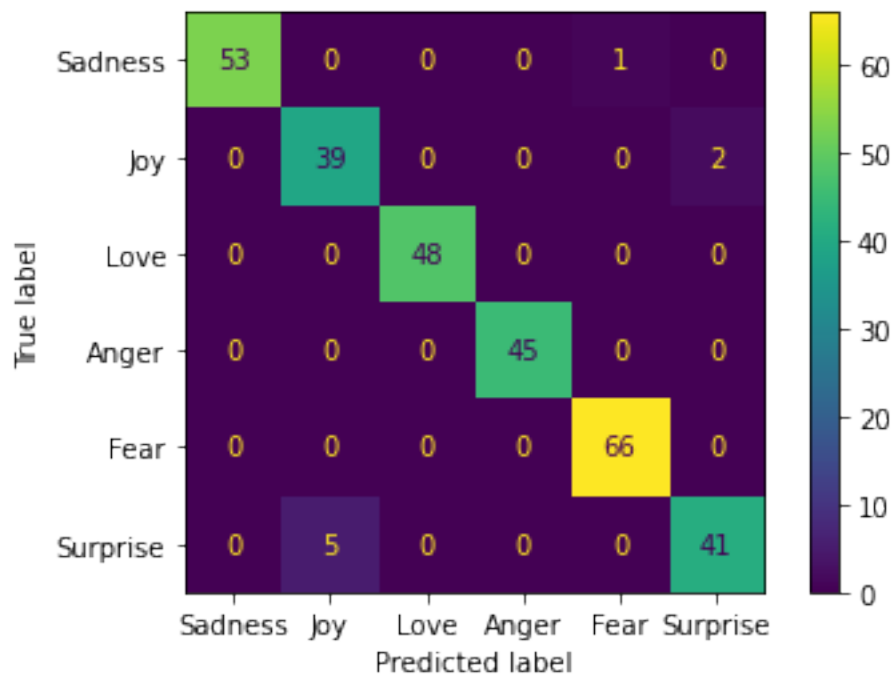Recall = 0.9731801518599149
F1 Score = 0.9732798571819838

Validation
Training Classification Report:

	precision	recall	f1-score	support
anger	1.00	0.98	0.99	54

	precision	recall	f1-score	support
fear	0.89	0.95	0.92	41
joy	1.00	1.00	1.00	48
love	1.00	1.00	1.00	45
sadness	0.99	1.00	0.99	66
surprise	0.95	0.89	0.92	46
accuracy			0.97	300
macro avg	0.97	0.97	0.97	300
weighted avg	0.97	0.97	0.97	300

Training Confusion Matrix:

Accuracy = 0.9733333333333334
Precision = 0.9708211058870552
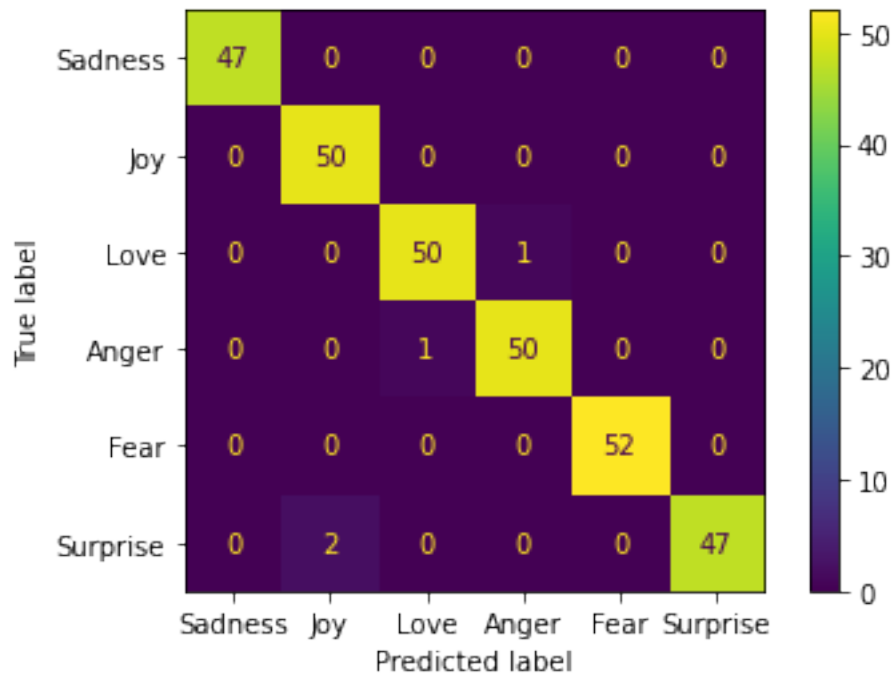Recall = 0.9706675569171149
F1 Score = 0.9703551303408777

Test
Training Classification Report:

	precision	recall	f1-score	support
anger	1.00	1.00	1.00	47
fear	0.96	1.00	0.98	50
joy	0.98	0.98	0.98	51
love	0.98	0.98	0.98	51
sadness	1.00	1.00	1.00	52
surprise	1.00	0.96	0.98	49

```
   accuracy                                0.99        300
  macro avg         0.99        0.99        0.99        300
weighted avg        0.99        0.99        0.99        300
```

Training Confusion Matrix:


```
Accuracy =  0.9866666666666667
Precision =  0.9870537958773253
Recall =  0.9866613311991465
F1 Score =  0.9867238562091504
```

Exercise 8

Exercise 9

Exercise 10
Blank space for trying things out.