# Emotion Detection Using Text

### Import Libraries

[156]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder
from sklearn.metrics import accuracy_score
from gensim.models import KeyedVectors
import tensorflow as tf
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Embedding, LSTM, Bidirectional,␣
  ↪Dropout
from tensorflow.keras.callbacks import EarlyStopping
from tensorflow.keras.preprocessing.sequence import pad_sequences
from sklearn.metrics import classification_report
from tensorflow.keras.models import save_model
from wordcloud import WordCloud
import pickle
import nltk
import warnings
from nltk.corpus import stopwords

nltk.download('stopwords')

warnings.filterwarnings("ignore")

%matplotlib inline
```

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

### Merging the Dataset

[130]:
```
def concatenate_files(file_list, output_file):
    with open(output_file, 'w') as outfile:
        for file_name in file_list:
            with open(file_name, 'r') as infile:
                for line in infile:
                    outfile.write(line)

file_list = ['train.txt', 'test.txt', 'val.txt']
output_file = 'dataset.txt'

concatenate_files(file_list, output_file)

print("Files concatenated successfully as 'dataset.txt'")
```

```
Files concatenated successfully as 'dataset.txt'
```

### Load the Dataset

[131]:
```
df = pd.read_csv("dataset.txt", delimiter=';', header=None, names=['Sentences',␣
 ↪'Target'])
sentences = df['Sentences'].values
emotions = df['Target'].values
```

### Dataset Exploration

[79]:
```
print(df.head())
```

```
                                           Sentences   Target
0                            i didnt feel humiliated  sadness
1  i can go from feeling so hopeless to so damned…  sadness
2   im grabbing a minute to post i feel greedy wrong    anger
3  i am ever feeling nostalgic about the fireplac…     love
4                               i am feeling grouchy    anger
```

[80]:
```
print(df.shape)
```

```
(20000, 2)
```

[81]:
```
print(df.info())
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 20000 entries, 0 to 19999
Data columns (total 2 columns):
 #   Column     Non-Null Count  Dtype
---  ------     --------------  -----
 0   Sentences  20000 non-null  object
 1   Target     20000 non-null  object
dtypes: object(2)
memory usage: 312.6+ KB
None
```

[82]:
```
df.isnull().sum()
```

```
[82]: Sentences    0
      Target       0
      dtype: int64
```

```
[83]: print(df['Target'].unique())
```

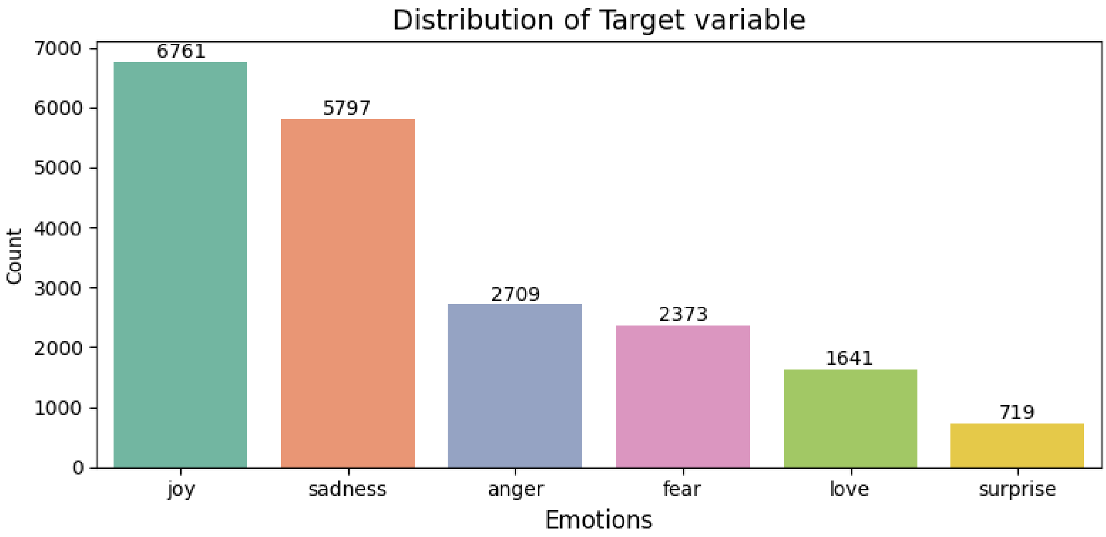
```
['sadness' 'anger' 'love' 'surprise' 'fear' 'joy']
```

```
[84]: print((df.Target.value_counts() / df.shape[0] * 100).round(2))
```

```
Target
joy         33.80
sadness     28.98
anger       13.54
fear        11.86
love         8.20
surprise     3.60
Name: count, dtype: float64
```

### Distribution of Target Variable

```
[85]: plt.figure(figsize=(8, 4))

      ax = sns.countplot(x='Target', data=df, palette='Set2', order=df['Target'].
        ↪value_counts().index)

      for p in ax.patches:
          ax.annotate(format(p.get_height(), '.0f'),
                      (p.get_x() + p.get_width() / 2., p.get_height()),
                      ha = 'center', va = 'center',
                      xytext = (0, 5),
                      textcoords = 'offset points')

      plt.xlabel('Emotions', fontsize=12)
      plt.ylabel('Count', fontsize=10)
      plt.title('Distribution of Target variable', fontsize=14)

      plt.tight_layout()
      plt.show()
```



```
[86]: df["Sentences_length"] = [len(i) for i in df["Sentences"]]
```

```
[87]: df.head(5)
```

```
[87]:
                                           Sentences   Target  \
0                            i didnt feel humiliated  sadness
1  i can go from feeling so hopeless to so damned…  sadness
2   im grabbing a minute to post i feel greedy wrong    anger
3  i am ever feeling nostalgic about the fireplac…     love
4                               i am feeling grouchy    anger

   Sentences_length
0                23
1               108
2                48
3                92
4                20
```

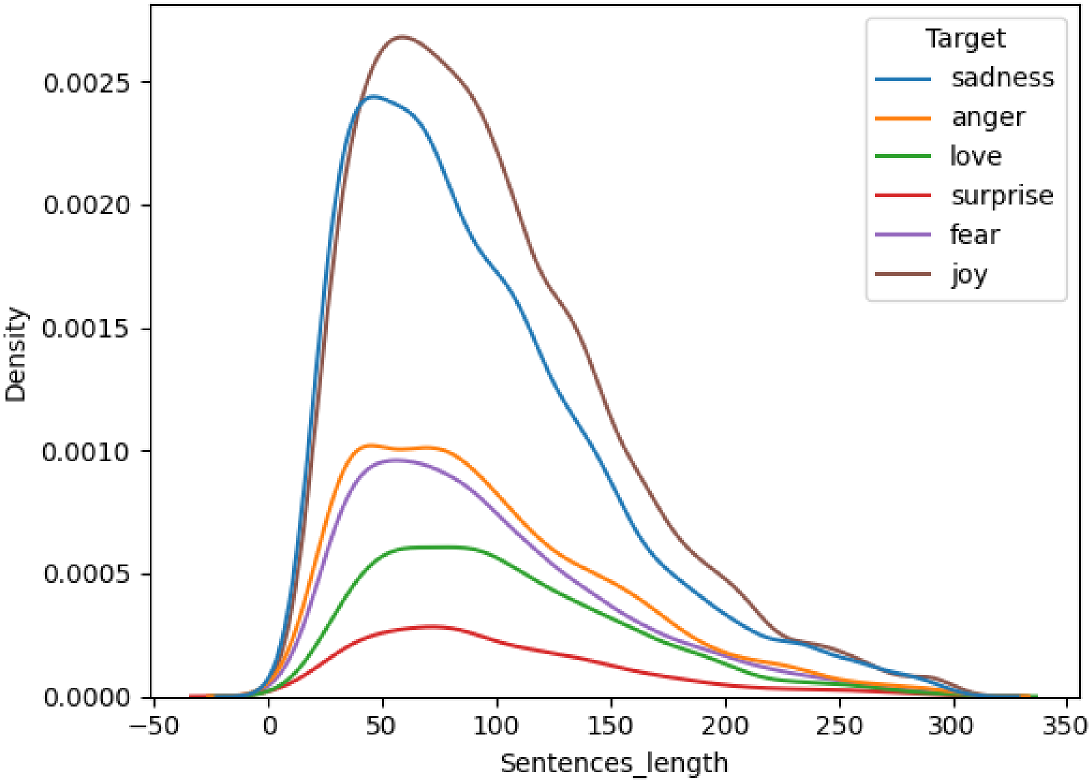
### Max and Min Sentence length

```
[88]: print(df['Sentences_length'].max())
      print(df['Sentences_length'].min())
```

```
300
7
```

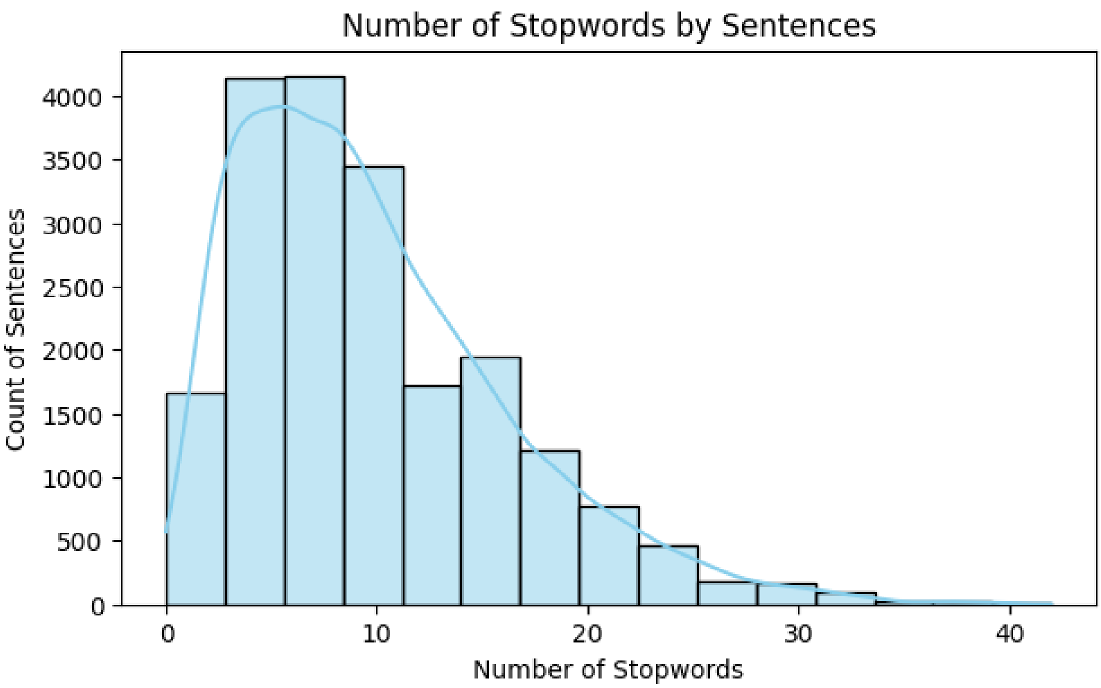
```
[89]: sns.kdeplot(x=df["Sentences_length"], hue=df["Target"])
```

```
[89]: <Axes: xlabel='Sentences_length', ylabel='Density'>
```



**Number of Stopwords by Sentences**

[105]:
```
def count_stopwords(sentence):
    stop_words = set(stopwords.words('english'))
    tokens = sentence.split()
    return sum(1 for word in tokens if word.lower() in stop_words)

df['Stopword_Count'] = df['Sentences'].apply(count_stopwords)

plt.figure(figsize=(7, 4))
sns.histplot(df['Stopword_Count'], bins=15, kde=True, color='Skyblue')
plt.xlabel('Number of Stopwords')
plt.ylabel('Count of Sentences')
plt.title('Number of Stopwords by Sentences')
plt.show()
```



**Removing the Stopwords**

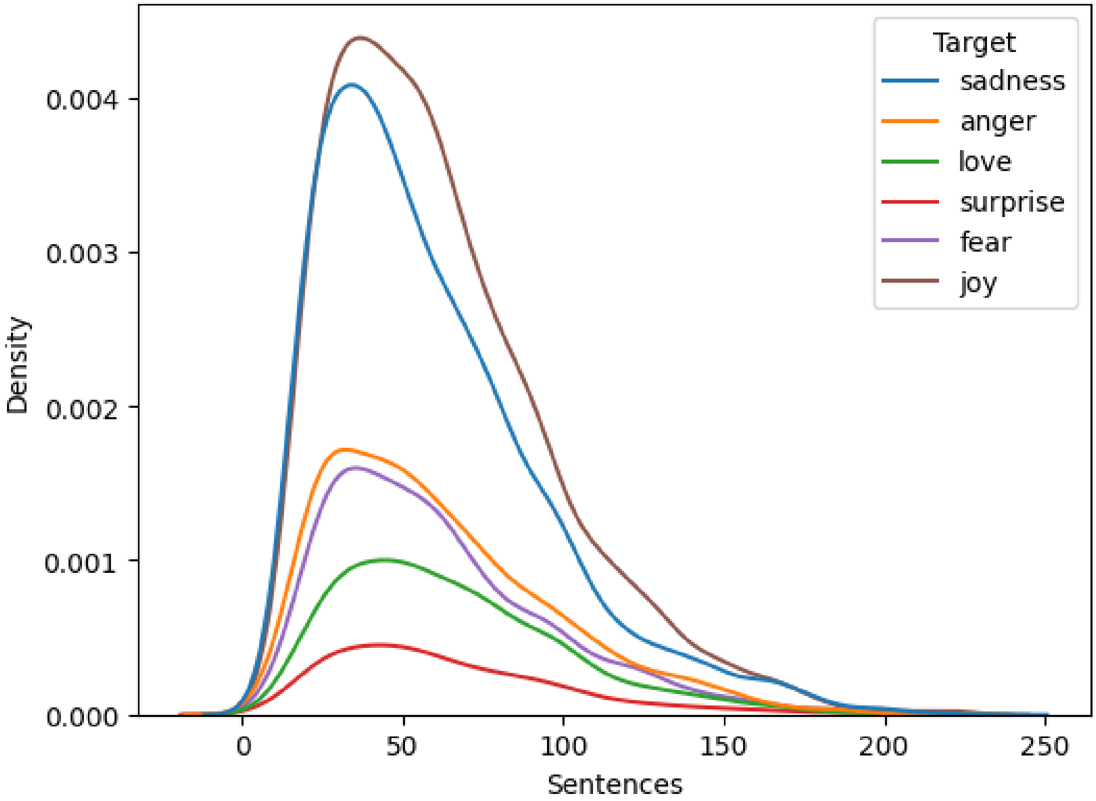
[106]:
```
stop_words = set(stopwords.words('english'))
```

[107]:
```
def remove_stopwords(text):
    tokens = text.split()
    filtered_tokens = [word for word in tokens if word.lower() not in␣
 ↪stop_words]
    return ' '.join(filtered_tokens)

df['Sentences'] = df['Sentences'].apply(remove_stopwords)
```

**Plot for words in Sentences after stopwords removal**

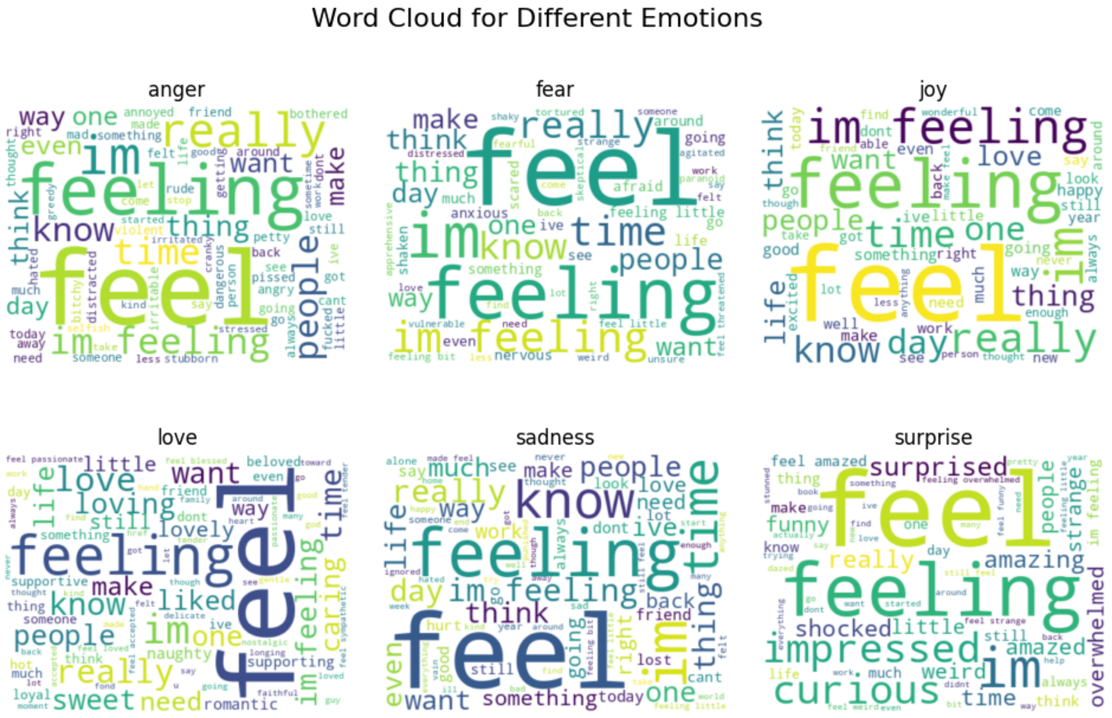
[108]:
```
sns.kdeplot(data=df, x=df["Sentences"].str.len(), hue=df["Target"])
```

[108]:
```
<Axes: xlabel='Sentences', ylabel='Density'>
```



### Word Cloud for Different Emotions

```
[109]: def generate_wordcloud(category_sentences, ax, title):
           wordcloud = WordCloud(width=400, height=300, background_color ='white', min_font_size = 10).generate(' '.join(category_sentences))
           ax.imshow(wordcloud, interpolation='bilinear')
           ax.axis('off')
           ax.set_title(title)

       category_groups = df.groupby('Target')['Sentences'].apply(list)

       fig, axs = plt.subplots(2, 3, figsize=(12, 7))
       fig.subplots_adjust(wspace=0.1)

       for i, (category, sentences) in enumerate(category_groups.items()):
           row = i // 3
           col = i % 3
           generate_wordcloud(sentences, axs[row, col], category)

       plt.suptitle('Word Cloud for Different Emotions', fontsize=16)
plt.show()
```



```
[116]: df.drop(["Sentences_length","Stopword_Count"],axis = 1)
```

```
[116]:                                              Sentences   Target
       0                                 didnt feel humiliated  sadness
       1      go feeling hopeless damned hopeful around some…  sadness
       2              im grabbing minute post feel greedy wrong    anger
       3      ever feeling nostalgic fireplace know still pr…     love
       4                                       feeling grouchy    anger
       …                                                   …      …
       19995  im ssa examination tomorrow morning im quite w…  sadness
       19996  constantly worry fight nature push limits inne…      joy
       19997         feel important share info experience thing      joy
       19998  truly feel passionate enough something stay tr…      joy
       19999  feel like wanna buy cute make see online even one      joy

       [20000 rows x 2 columns]
```

### Downloading the Pretrained Model - GLoVe

```
[35]: !wget https://huggingface.co/stanfordnlp/glove/resolve/main/glove.6B.zip
```

```
--2024-05-07 14:45:48--
```

```
https://huggingface.co/stanfordnlp/glove/resolve/main/glove.6B.zip
Resolving huggingface.co (huggingface.co)… 65.8.178.12, 65.8.178.118,
65.8.178.93, …
Connecting to huggingface.co (huggingface.co)|65.8.178.12|:443… connected.
HTTP request sent, awaiting response… 302 Found
Location: https://cdn-lfs.huggingface.co/stanfordnlp/glove/6471382cdd837544bf3ac
72497a38715e845897d265b2b424b4761832009c837?response-content-disposition=attachm
ent%3B+filename*%3DUTF-8%27%27glove.6B.zip%3B+filename%3D%22glove.6B.zip%22%3B&r
esponse-content-type=application%2Fzip&Expires=1715352348&Policy=eyJTdGF0ZW1lbnQ
iOlt7IkNvbmRpdGlvbiI6eyJEYXRlTGVzc1RoYW4iOnsiQVdTOkVwb2NoVGltZSI6MTcxNTM1MjM0OH1
9LCJSZXNvdXJjZSI6Imh0dHBzOi8vY2RuLWxmcy5odWdnaW5nZmFjZS5jby9zdGFuZm9yZG5scC9nbG9
2ZS82NDcxMzgyY2RkODM3NTQ0YmYzYWM3MjQ5N2EzODcxNWU4NDU4OTdkMjY1YjJiNDI0YjQ3NjE4MzI
wMDljODM3P3Jlc3BvbnNlLWNvbnRlbnQtZGlzcG9zaXRpb249KiZyZXNwb25zZS1jb250ZW50LXR5cGU
9KiJ9XX0_&Signature=elvMx%7EY0z8LyztBDd3Ic-wEEGYpU1cZ12fP%7EPHjlBjzwlgRxgdmzqFve
fml%7EXAjR8%7E44xhBOWEoukJ9jlkn8smSkD4XMK1de-
CkkBQ%7EeddFlUgvG93lSFSvNgntbN7AMxG9yDLvJZPWKhh7xBQ2oIpR26LIKdrAhrjpHf-YmRWxKWZ7
HvMrU%7ECDP8pPyPRZVyB0xiPLavBTTVLFfXwyaPP43RbKCQw%7EYNqcwudMrbXdPrjaXgJSTj3r4lwl
PZI%7EI0E7BI%7EzzoVGfSMs0kSOkcYcVZmoLkXWoRuqhHGWBYlkGRPcVKtUMUl2VeuhAwX%7Efpjd5X
XlwB2REKvPVo8IV7Q__&Key-Pair-Id=KVTP0A1DKRTAX [following]
--2024-05-07 14:45:48--  https://cdn-lfs.huggingface.co/stanfordnlp/glove/647138
2cdd837544bf3ac72497a38715e845897d265b2b424b4761832009c837?response-content-disp
osition=attachment%3B+filename*%3DUTF-8%27%27glove.6B.zip%3B+filename%3D%22glove
.6B.zip%22%3B&response-content-type=application%2Fzip&Expires=1715352348&Policy=
eyJTdGF0ZW1lbnQiOlt7IkNvbmRpdGlvbiI6eyJEYXRlTGVzc1RoYW4iOnsiQVdTOkVwb2NoVGltZSI6
MTcxNTM1MjM0OH19LCJSZXNvdXJjZSI6Imh0dHBzOi8vY2RuLWxmcy5odWdnaW5nZmFjZS5jby9zdGFu
Zm9yZG5scC9nbG92ZS82NDcxMzgyY2RkODM3NTQ0YmYzYWM3MjQ5N2EzODcxNWU4NDU4OTdkMjY1YjJi
NDI0YjQ3NjE4MzIwMDljODM3P3Jlc3BvbnNlLWNvbnRlbnQtZGlzcG9zaXRpb249KiZyZXNwb25zZS1j
b250ZW50LXR5cGU9KiJ9XX0_&Signature=elvMx%7EY0z8LyztBDd3Ic-wEEGYpU1cZ12fP%7EPHjlB
jzwlgRxgdmzqFvefml%7EXAjR8%7E44xhBOWEoukJ9jlkn8smSkD4XMK1de-
CkkBQ%7EeddFlUgvG93lSFSvNgntbN7AMxG9yDLvJZPWKhh7xBQ2oIpR26LIKdrAhrjpHf-YmRWxKWZ7
HvMrU%7ECDP8pPyPRZVyB0xiPLavBTTVLFfXwyaPP43RbKCQw%7EYNqcwudMrbXdPrjaXgJSTj3r4lwl
PZI%7EI0E7BI%7EzzoVGfSMs0kSOkcYcVZmoLkXWoRuqhHGWBYlkGRPcVKtUMUl2VeuhAwX%7Efpjd5X
XlwB2REKvPVo8IV7Q__&Key-Pair-Id=KVTP0A1DKRTAX
Resolving cdn-lfs.huggingface.co (cdn-lfs.huggingface.co)… 108.157.173.21,
108.157.173.84, 108.157.173.44, …
Connecting to cdn-lfs.huggingface.co (cdn-
lfs.huggingface.co)|108.157.173.21|:443… connected.
HTTP request sent, awaiting response… 200 OK
Length: 862182753 (822M) [application/zip]
Saving to: ‘glove.6B.zip’

glove.6B.zip        100%[===================>] 822.24M  58.8MB/s    in 12s

2024-05-07 14:46:00 (69.1 MB/s) - ‘glove.6B.zip’ saved [862182753/862182753]
```

[36]:

```
import zipfile
zip_ref = zipfile.ZipFile("glove.6B.zip", 'r')
zip_ref.extractall(".")
zip_ref.close()
```

### Load the model

[37]:

```
def load_glove_model(File):
    print("Loading Glove Model")
    glove_model = {}
    with open('glove.6B.300d.txt','r') as f:
        for line in f:
            split_line = line.split()
            word = split_line[0]
            embedding = np.array(split_line[1:], dtype=np.float64)
            glove_model[word] = embedding
    print(f"{len(glove_model)} words loaded!")
    return glove_model
```

[38]:

```
glove_model = load_glove_model('glove.6B.300d.txt')
```

```
Loading Glove Model
400001 words loaded!
```

### Tokenize the sentences and create word-to-index mapping

[161]:

```
word_to_index = {}
index = 1  # Start index from 1, leaving 0 for padding
for sentence in sentences:
    for word in sentence.split():
        if word not in word_to_index:
            word_to_index[word] = index
            index += 1
```

### Creating an embedding matrix

[136]:

```
embedding_matrix = np.zeros((len(word_to_index) + 1, len(glove_model['the']))) ␣
 ↪# Add 1 to include padding token
for word, index in word_to_index.items():
    if word in glove_model:
        embedding_matrix[index] = glove_model[word]
```

### Performing label encoding on the target labels

[137]:

```
label_encoder = LabelEncoder()
encoded_emotions = label_encoder.fit_transform(emotions)
```

### Split the dataset into training, validation, and testing sets

[138]:

```
X_train, X_test, y_train, y_test = train_test_split(sentences,␣
 ↪encoded_emotions, test_size=0.2, random_state=42)
X_train, X_val, y_train, y_val = train_test_split(X_train, y_train, test_size=0.
 ↪1, random_state=42)
```

### Converting sentences to sequences of indices

[139]:

```
X_train_sequences = [[word_to_index[word] for word in sentence.split() if word␣
 ↪in word_to_index] for sentence in X_train]
X_val_sequences = [[word_to_index[word] for word in sentence.split() if word in␣
 ↪word_to_index] for sentence in X_val]
X_test_sequences = [[word_to_index[word] for word in sentence.split() if word␣
 ↪in word_to_index] for sentence in X_test]
```

### Padding sequences to make them of equal length

[140]:

```
max_sequence_length = max(len(sequence) for sequence in X_train_sequences +␣
 ↪X_val_sequences + X_test_sequences)
X_train_padded = pad_sequences(X_train_sequences, maxlen=max_sequence_length,␣
 ↪padding='post')
X_val_padded = pad_sequences(X_val_sequences, maxlen=max_sequence_length,␣
 ↪padding='post')
X_test_padded = pad_sequences(X_test_sequences, maxlen=max_sequence_length,␣
 ↪padding='post')
```

### Train the Model

[141]:

```
bilstm_model = Sequential([
    Embedding(input_dim=len(word_to_index) + 1,␣
 ↪output_dim=len(glove_model['the']), weights=[embedding_matrix],␣
 ↪input_length=max_sequence_length, trainable=False),
    Bidirectional(LSTM(64, dropout=0.2, recurrent_dropout=0.2)),
    Dropout(0.2),  # Dropout layer added after the Bidirectional LSTM layer
    Dense(len(label_encoder.classes_), activation='softmax')
])
bilstm_model.compile(loss='sparse_categorical_crossentropy', optimizer='adam',␣
 ↪metrics=['accuracy'])

# Early stopping criteria
early_stopping = EarlyStopping(monitor='val_loss', patience=3,␣
 ↪restore_best_weights=True)
```

[159]:

```
bilstm_model.summary()
```

```
Model: "sequential"

_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 embedding (Embedding)       (None, 66, 300)           5129100

 bidirectional (Bidirection  (None, 128)               186880
 al)

 dropout (Dropout)           (None, 128)               0

 dense (Dense)               (None, 6)                 774

=================================================================
Total params: 5316754 (20.28 MB)
Trainable params: 187654 (733.02 KB)
Non-trainable params: 5129100 (19.57 MB)
_________________________________________________________________
```

[142]:

```
bilstm_history = bilstm_model.fit(X_train_padded, y_train, epochs=25, batch_size=32, validation_data=(X_val_padded, y_val), callbacks=[early_stopping])
```

```
Epoch 1/25
450/450 [==============================] - 172s 369ms/step - loss: 1.2147 -
accuracy: 0.5519 - val_loss: 0.7651 - val_accuracy: 0.7163
Epoch 2/25
450/450 [==============================] - 166s 368ms/step - loss: 0.6749 -
accuracy: 0.7642 - val_loss: 0.4767 - val_accuracy: 0.8300
Epoch 3/25
450/450 [==============================] - 219s 488ms/step - loss: 0.4701 -
accuracy: 0.8383 - val_loss: 0.3492 - val_accuracy: 0.8662
Epoch 4/25
450/450 [==============================] - 149s 332ms/step - loss: 0.3659 -
accuracy: 0.8722 - val_loss: 0.3035 - val_accuracy: 0.8869
Epoch 5/25
450/450 [==============================] - 160s 357ms/step - loss: 0.3098 -
accuracy: 0.8865 - val_loss: 0.2732 - val_accuracy: 0.8950
Epoch 6/25
450/450 [==============================] - 146s 325ms/step - loss: 0.2547 -
accuracy: 0.9043 - val_loss: 0.2493 - val_accuracy: 0.9050
Epoch 7/25
450/450 [==============================] - 153s 341ms/step - loss: 0.2297 -
accuracy: 0.9133 - val_loss: 0.2251 - val_accuracy: 0.9069
Epoch 8/25
450/450 [==============================] - 141s 313ms/step - loss: 0.2001 -
accuracy: 0.9233 - val_loss: 0.2120 - val_accuracy: 0.9100
Epoch 9/25
450/450 [==============================] - 152s 337ms/step - loss: 0.1865 -
accuracy: 0.9272 - val_loss: 0.2197 - val_accuracy: 0.9112
Epoch 10/25
450/450 [==============================] - 146s 325ms/step - loss: 0.1678 -
```

```
accuracy: 0.9331 - val_loss: 0.2095 - val_accuracy: 0.9150
Epoch 11/25
450/450 [==============================] - 157s 348ms/step - loss: 0.1530 -
accuracy: 0.9408 - val_loss: 0.2150 - val_accuracy: 0.9081
Epoch 12/25
450/450 [==============================] - 151s 336ms/step - loss: 0.1455 -
accuracy: 0.9410 - val_loss: 0.2093 - val_accuracy: 0.9119
Epoch 13/25
450/450 [==============================] - 144s 321ms/step - loss: 0.1328 -
accuracy: 0.9447 - val_loss: 0.2094 - val_accuracy: 0.9131
Epoch 14/25
450/450 [==============================] - 151s 335ms/step - loss: 0.1226 -
accuracy: 0.9520 - val_loss: 0.2132 - val_accuracy: 0.9169
Epoch 15/25
450/450 [==============================] - 150s 333ms/step - loss: 0.1134 -
accuracy: 0.9532 - val_loss: 0.2303 - val_accuracy: 0.9169
```

### Evaluating the model

[143]:
```
loss, accuracy = bilstm_model.evaluate(X_test_padded, y_test)
print("BiLSTM Accuracy:", accuracy)
```

```
125/125 [==============================] - 5s 41ms/step - loss: 0.2327 -
accuracy: 0.9062
BiLSTM Accuracy: 0.90625
```

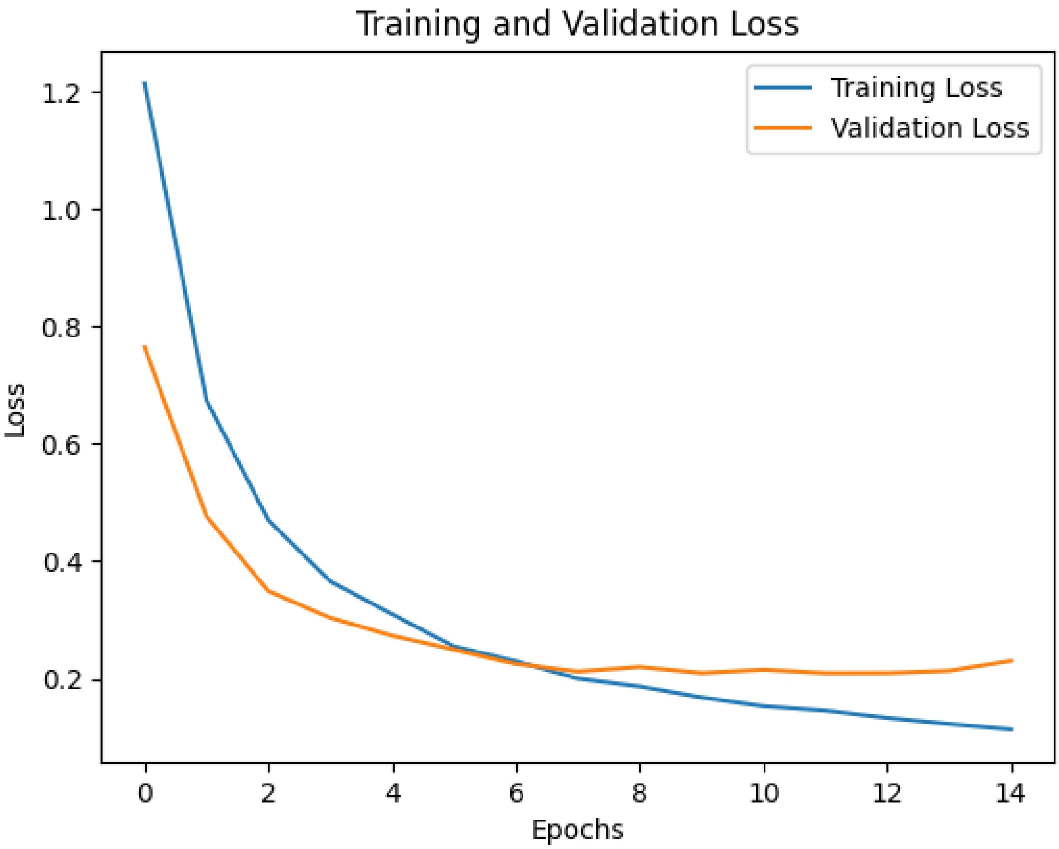
[145]:
```
y_pred_prob = bilstm_model.predict(X_test_padded)
y_pred = np.argmax(y_pred_prob, axis=1)

print("Classification Report:")
print(classification_report(y_test, y_pred, target_names=label_encoder.
 ↪classes_))
```

```
125/125 [==============================] - 18s 122ms/step
Classification Report:
              precision    recall  f1-score   support

       anger       0.90      0.93      0.91       536
        fear       0.86      0.83      0.84       458
         joy       0.94      0.92      0.93      1339
        love       0.78      0.84      0.81       335
     sadness       0.95      0.94      0.95      1173
    surprise       0.73      0.85      0.78       159

    accuracy                           0.91      4000
   macro avg       0.86      0.88      0.87      4000
weighted avg       0.91      0.91      0.91      4000
```

**Plot for training and validation loss**

[146]:

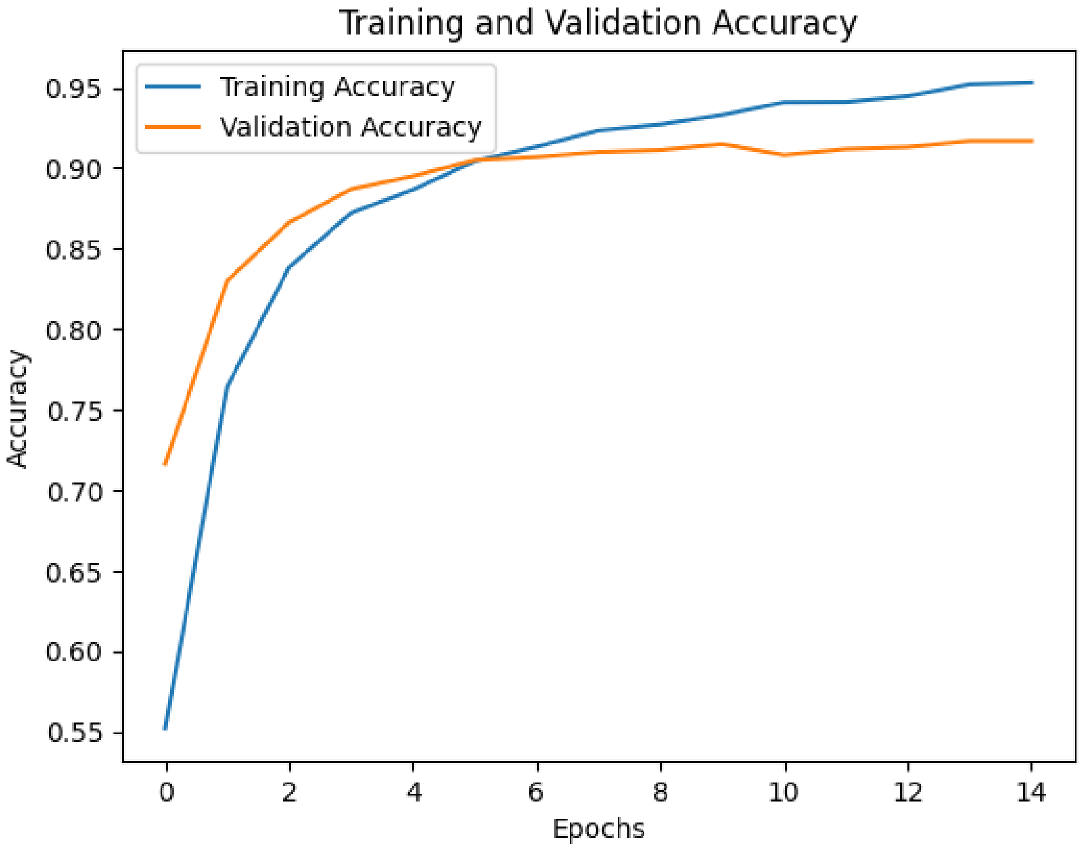
```
plt.plot(bilstm_history.history['loss'], label='Training Loss')
plt.plot(bilstm_history.history['val_loss'], label='Validation Loss')
plt.title('Training and Validation Loss')
plt.xlabel('Epochs')
plt.ylabel('Loss')
plt.legend()
plt.show()
```



**Plot for training and validation accuracy**

[147]:

```
plt.plot(bilstm_history.history['accuracy'], label='Training Accuracy')
plt.plot(bilstm_history.history['val_accuracy'], label='Validation Accuracy')
plt.title('Training and Validation Accuracy')
plt.xlabel('Epochs')
plt.ylabel('Accuracy')
plt.legend()
plt.show()
```



**Predicting New Sentences**

[154]:

```python
new_sentences = [
    "I feel excited about the upcoming project",
    "This situation makes me anxious",
    "I am calm and relaxed right now"
]

tokenizer = lambda x: [[word_to_index[word] for word in sentence.split() if word in word_to_index] for sentence in x]

new_sequences = tokenizer(new_sentences)
new_sequences_padded = pad_sequences(new_sequences, maxlen=max_sequence_length, padding='post')

predictions = bilstm_model.predict(new_sequences_padded)

predicted_emotions = label_encoder.inverse_transform(np.argmax(predictions, axis=1))
```

```python
print("Predicted Emotions for New Sentences:")
for sentence, emotion in zip(new_sentences, predicted_emotions):
    print(f"Sentence: {sentence} | Predicted Emotion: {emotion}")
```

```
1/1 [==============================] - 1s 1s/step
Predicted Emotions for New Sentences:
Sentence: I feel excited about the upcoming project | Predicted Emotion: joy
Sentence: This situation makes me anxious | Predicted Emotion: fear
Sentence: I am calm and relaxed right now | Predicted Emotion: joy
```

### Save Model

[157]:
```python
bilstm_model.save('bilstm_model.h5')

with open('bilstm_model.pkl', 'wb') as f:
    pickle.dump(bilstm_model, f)

print("Model saved successfully!")
```

```
Model saved successfully!
```