```python
#Performing Twitter Hate Speech Recognition using LSTM(Long Short Term
Model)

import pandas as pd
import numpy as np
import tensorflow as tf
from tensorflow.keras.preprocessing.text import Tokenizer
from tensorflow.keras.preprocessing.sequence import pad_sequences
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Embedding, LSTM, Dense, Dropout
from sklearn.model_selection import train_test_split
from sklearn.metrics import classification_report, accuracy_score
import nltk
from nltk.corpus import stopwords
import re

#Loading the Sentiment 140 dataset
data =
pd.read_csv('/Users/Andrea/Desktop/training.1600000.processed.noemotic
on.csv', encoding='latin-1', header=None)
data.columns = ['target', 'ids', 'date', 'flag', 'user', 'text']

data.head(50)
```

```
    target         ids                          date      flag  \
0        0  1467810369  Mon Apr 06 22:19:45 PDT 2009  NO_QUERY
1        0  1467810672  Mon Apr 06 22:19:49 PDT 2009  NO_QUERY
2        0  1467810917  Mon Apr 06 22:19:53 PDT 2009  NO_QUERY
3        0  1467811184  Mon Apr 06 22:19:57 PDT 2009  NO_QUERY
4        0  1467811193  Mon Apr 06 22:19:57 PDT 2009  NO_QUERY
5        0  1467811372  Mon Apr 06 22:20:00 PDT 2009  NO_QUERY
6        0  1467811592  Mon Apr 06 22:20:03 PDT 2009  NO_QUERY
7        0  1467811594  Mon Apr 06 22:20:03 PDT 2009  NO_QUERY
8        0  1467811795  Mon Apr 06 22:20:05 PDT 2009  NO_QUERY
9        0  1467812025  Mon Apr 06 22:20:09 PDT 2009  NO_QUERY
10       0  1467812416  Mon Apr 06 22:20:16 PDT 2009  NO_QUERY
11       0  1467812579  Mon Apr 06 22:20:17 PDT 2009  NO_QUERY
12       0  1467812723  Mon Apr 06 22:20:19 PDT 2009  NO_QUERY
13       0  1467812771  Mon Apr 06 22:20:19 PDT 2009  NO_QUERY
14       0  1467812784  Mon Apr 06 22:20:20 PDT 2009  NO_QUERY
15       0  1467812799  Mon Apr 06 22:20:20 PDT 2009  NO_QUERY
16       0  1467812964  Mon Apr 06 22:20:22 PDT 2009  NO_QUERY
17       0  1467813137  Mon Apr 06 22:20:25 PDT 2009  NO_QUERY
18       0  1467813579  Mon Apr 06 22:20:31 PDT 2009  NO_QUERY
19       0  1467813782  Mon Apr 06 22:20:34 PDT 2009  NO_QUERY
20       0  1467813985  Mon Apr 06 22:20:37 PDT 2009  NO_QUERY
21       0  1467813992  Mon Apr 06 22:20:38 PDT 2009  NO_QUERY
22       0  1467814119  Mon Apr 06 22:20:40 PDT 2009  NO_QUERY
23       0  1467814180  Mon Apr 06 22:20:40 PDT 2009  NO_QUERY
24       0  1467814192  Mon Apr 06 22:20:41 PDT 2009  NO_QUERY
```

```
25       0  1467814438  Mon Apr 06 22:20:44 PDT 2009  NO_QUERY
26       0  1467814783  Mon Apr 06 22:20:50 PDT 2009  NO_QUERY
27       0  1467814883  Mon Apr 06 22:20:52 PDT 2009  NO_QUERY
28       0  1467815199  Mon Apr 06 22:20:56 PDT 2009  NO_QUERY
29       0  1467815753  Mon Apr 06 22:21:04 PDT 2009  NO_QUERY
30       0  1467815923  Mon Apr 06 22:21:07 PDT 2009  NO_QUERY
31       0  1467815924  Mon Apr 06 22:21:07 PDT 2009  NO_QUERY
32       0  1467815988  Mon Apr 06 22:21:09 PDT 2009  NO_QUERY
33       0  1467816149  Mon Apr 06 22:21:11 PDT 2009  NO_QUERY
34       0  1467816665  Mon Apr 06 22:21:21 PDT 2009  NO_QUERY
35       0  1467816749  Mon Apr 06 22:21:20 PDT 2009  NO_QUERY
36       0  1467817225  Mon Apr 06 22:21:27 PDT 2009  NO_QUERY
37       0  1467817374  Mon Apr 06 22:21:30 PDT 2009  NO_QUERY
38       0  1467817502  Mon Apr 06 22:21:32 PDT 2009  NO_QUERY
39       0  1467818007  Mon Apr 06 22:21:39 PDT 2009  NO_QUERY
40       0  1467818020  Mon Apr 06 22:21:39 PDT 2009  NO_QUERY
41       0  1467818481  Mon Apr 06 22:21:46 PDT 2009  NO_QUERY
42       0  1467818603  Mon Apr 06 22:21:49 PDT 2009  NO_QUERY
43       0  1467818900  Mon Apr 06 22:21:53 PDT 2009  NO_QUERY
44       0  1467819022  Mon Apr 06 22:21:56 PDT 2009  NO_QUERY
45       0  1467819650  Mon Apr 06 22:22:05 PDT 2009  NO_QUERY
46       0  1467819712  Mon Apr 06 22:22:06 PDT 2009  NO_QUERY
47       0  1467819812  Mon Apr 06 22:22:07 PDT 2009  NO_QUERY
48       0  1467820206  Mon Apr 06 22:22:13 PDT 2009  NO_QUERY
49       0  1467820835  Mon Apr 06 22:22:25 PDT 2009  NO_QUERY

               user                                                text

0   _TheSpecialOne_  @switchfoot http://twitpic.com/2y1zl - Awww, t...

1     scotthamilton  is upset that he can't update his Facebook by ...

2          mattycus  @Kenichan I dived many times for the ball. Man...

3           ElleCTF    my whole body feels itchy and like its on fire

4            Karoli  @nationwideclass no, it's not behaving at all....

5          joy_wolf                      @Kwesidei not the whole crew

6           mybirch                                        Need a hug

7             coZZ  @LOLTrish hey  long time no see! Yes.. Rains a...

8   2Hood4Hollywood               @Tatiana_K nope they didn't have it

9           mimismo                          @twittera que me muera ?

10   erinx3leannexo        spring break in plain city... it's snowing
```

```
11     pardonlauren                          I just re-pierced my ears 
12             TLeC  @caregiving I couldn't bear to watch it.  And ...
13  robrobbierobert  @octolinz16 It it counts, idk why I did either...
14      bayofwolves  @smarrison i would've been the first, but i di...
15       HairByJess  @iamjazzyfizzle I wish I got to watch it with ...
16   lovesongwriter  Hollis' death scene will hurt me severely to w...
17         armotley                                about to file taxes 
18       starkissed  @LettyA ahh ive always wanted to see rent  lov...
19        gi_gi_bee  @FakerPattyPattz Oh dear. Were you drinking ou...
20           quanvu  @alydesigns i was out most of the day so didn'...
21       swinspeedx  one of my friend called me, and asked to meet ...
22        cooliodoc   @angry_barista I baked you a cake but I ated it 
23       viJILLante             this week is not going as i had hoped 
24       Ljelli3166                          blagh class at 8 tomorrow 
25    ChicagoCubbie     I hate when I have to call and wake people up 
26      KatieAngell  Just going to cry myself to sleep after watchi...
27            gagoo                            im sad now  Miss.Lilly
28          abel209  ooooh.... LOL  that leslie.... and ok I won't ...
29  BaptisteTheFool  Meh... Almost Lover is the exception... this t...
30        fatkat309  some1 hacked my account on aim  now i have to ...
31            EmCDL  @alielayus I want to go to promote GEAR AND GR...
32         merisssa  thought sleeping in was an option tomorrow but...
33         Pbearfox  @julieebaby awe i love you too!!!! 1 am here  ...
34             jsoo  @HumpNinja I cry my asian eyes to sleep at night 
35   scarletletterm  ok I'm sick and spent an hour sitting in the s...
36      crosland_12  @cocomix04 ill tell ya the story later  not a ...
```

```
37          ajaxpro  @MissXu sorry! bed time came here (GMT+1)   ht...
38          Tmttq86  @fleurylis I don't either. Its depressing. I d...
39   Anthony_Nguyen  Bed. Class 8-12. Work 12-3. Gym 3-5 or 6. Then...
40       itsanimesh  really don't feel like getting up today... but...
41        lionslamb  He's the reason for the teardrops on my guitar...
42        kennypham  Sad, sad, sad. I don't know why but I hate thi...
43   DdubsShellBell  @JonathanRKnight Awww I soo wish I was there t...
44      hpfangirl94  Falling asleep. Just heard about that Tracy gi...
45        antzpantz  @Viennah Yay! I'm happy for you with your job!...
46        labrt2004  Just checked my user timeline on my blackberry...
47        IrisJumbe  Oh man...was ironing @jeancjumbe's fave top to...
48         peacoats  is strangely sad about LiLo and SamRo breaking...
49         cyantist  @tea oh! i'm so sorry  i didn't think about th...
```

```
data.tail(150)
```

```
         target         ids                          date      flag  \
1599850       4  2193552448  Tue Jun 16 08:36:46 PDT 2009  NO_QUERY
1599851       4  2193552454  Tue Jun 16 08:36:46 PDT 2009  NO_QUERY
1599852       4  2193552500  Tue Jun 16 08:36:47 PDT 2009  NO_QUERY
1599853       4  2193552501  Tue Jun 16 08:36:47 PDT 2009  NO_QUERY
1599854       4  2193552510  Tue Jun 16 08:36:47 PDT 2009  NO_QUERY
...         ...         ...                           ...       ...
1599995       4  2193601966  Tue Jun 16 08:40:49 PDT 2009  NO_QUERY
1599996       4  2193601969  Tue Jun 16 08:40:49 PDT 2009  NO_QUERY
1599997       4  2193601991  Tue Jun 16 08:40:49 PDT 2009  NO_QUERY
1599998       4  2193602064  Tue Jun 16 08:40:49 PDT 2009  NO_QUERY
1599999       4  2193602129  Tue Jun 16 08:40:50 PDT 2009  NO_QUERY

                    user
text
1599850      jenniehager  sick, sick, sick today, but still fingers
cros...
1599851   YessicaCarcamo  Getting ready to go out   I have to go to
mac ...
1599852        afarley08  loves visitors so if you are goin to the
Aeros...
1599853      Jay_Cousins  Nice out, but If I am going to leave here at
```

```
6...
1599854    laughingstars       @WillaRyan At least trees are being
spared.
...                  ...
...
1599995  AmandaMarie1028  Just woke up. Having no school is the best
fee...
1599996      TheWDBoards  TheWDB.com - Very cool to hear old Walt
interv...
1599997           bpbabe  Are you ready for your MoJo Makeover? Ask me
f...
1599998     tinydiamondz  Happy 38th Birthday to my boo of alll
time!!! ...
1599999   RyanTrevMorris  happy #charitytuesday @theNSPCC
@SparksCharity...

[150 rows x 6 columns]
```

```
data.shape
```

```
(1600000, 6)
```

```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1600000 entries, 0 to 1599999
Data columns (total 6 columns):
 #   Column  Non-Null Count    Dtype
---  ------  --------------    -----
 0   target  1600000 non-null  int64
 1   ids     1600000 non-null  int64
 2   date    1600000 non-null  object
 3   flag    1600000 non-null  object
 4   user    1600000 non-null  object
 5   text    1600000 non-null  object
dtypes: int64(2), object(4)
memory usage: 73.2+ MB
```

```
data = data[['target', 'text']]

#Target values mapped to binary (0 = negative, 1 = positive)
#Ignore the neutral tweets (target = 2)
data = data[data['target'] != 2]
data['target'] = data['target'].map({0: 0, 4: 1})


stop_words = set(stopwords.words('english'))

def preprocess_text(text):
    text = re.sub(r'http\S+', '', text)  #Remove URLs
    text = re.sub(r'@\w+', '', text)     #Remove mentions
    text = re.sub(r'#', '', text)        #Remove hashtags
    text = re.sub(r'\d+', '', text)      #Remove numbers
    text = re.sub(r'[^\w\s]', '', text)  #Remove punctuation
    text = text.lower()                  #Lowercase
    text = ' '.join([word for word in text.split() if word not in
stop_words])
    return text

data['cleaned_text'] = data['text'].apply(preprocess_text)

#Tokenize the text
tokenizer = Tokenizer(num_words=10000, oov_token='<OOV>')
tokenizer.fit_on_texts(data['cleaned_text'])
sequences = tokenizer.texts_to_sequences(data['cleaned_text'])

#Pad the sequences
padded_sequences = pad_sequences(sequences, padding='post', maxlen=50)

#Spitting the data
X_train, X_test, y_train, y_test = train_test_split(padded_sequences,
data['target'], test_size=0.2, random_state=42)

#Building the model
model = Sequential()
model.add(Embedding(input_dim=10000, output_dim=64, input_length=50))
model.add(LSTM(64, return_sequences=True))
model.add(Dropout(0.2))
model.add(LSTM(64))
model.add(Dropout(0.2))
model.add(Dense(1, activation='sigmoid'))


#Compliling the model
model.compile(optimizer='adam', loss='binary_crossentropy',
metrics=['accuracy'])



#Train the model
history = model.fit(X_train, y_train, epochs=5,
validation_data=(X_test, y_test), batch_size=32)
```

```
Epoch 1/5
```

```
/opt/anaconda3/lib/python3.11/site-packages/keras/src/layers/core/
embedding.py:90: UserWarning: Argument `input_length` is deprecated.
Just remove it.
  warnings.warn(
```

```
40000/40000 ━━━━━━━━━━━━━━━━━━━━ 726s 18ms/step - accuracy: 0.4997 -
loss: 0.6933 - val_accuracy: 0.4984 - val_loss: 0.6933
```

```
Epoch 2/5
40000/40000 ━━━━━━━━━━━━━━━━━━━━ 707s 18ms/step - accuracy: 0.4998 -
loss: 0.6932 - val_accuracy: 0.5016 - val_loss: 0.6932
Epoch 3/5
40000/40000 ━━━━━━━━━━━━━━━━━━━━ 727s 18ms/step - accuracy: 0.5000 -
loss: 0.6932 - val_accuracy: 0.4984 - val_loss: 0.6932
Epoch 4/5
40000/40000 ━━━━━━━━━━━━━━━━━━━━ 732s 18ms/step - accuracy: 0.4998 -
loss: 0.6932 - val_accuracy: 0.4984 - val_loss: 0.6932
Epoch 5/5
40000/40000 ━━━━━━━━━━━━━━━━━━━━ 3283s 82ms/step - accuracy: 0.4995 -
loss: 0.6932 - val_accuracy: 0.4984 - val_loss: 0.6932

model.summary()

Model: "sequential"

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━━━━━┓
┃ Layer (type)                     ┃ Output Shape           ┃
Param # ┃
┡━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━
━━━━━┩
│ embedding (Embedding)            │ (32, 50, 64)           │
640,000 │
├──────────────────────────────────┼────────────────────────┼──────────
─────┤
│ lstm (LSTM)                      │ (32, 50, 64)           │
33,024 │
├──────────────────────────────────┼────────────────────────┼──────────
─────┤
│ dropout (Dropout)                │ (32, 50, 64)           │
0 │
├──────────────────────────────────┼────────────────────────┼──────────
─────┤
│ lstm_1 (LSTM)                    │ (32, 64)               │
33,024 │
├──────────────────────────────────┼────────────────────────┼──────────
─────┤
│ dropout_1 (Dropout)              │ (32, 64)               │
0 │
├──────────────────────────────────┼────────────────────────┼──────────
─────┤
│ dense (Dense)                    │ (32, 1)                │
65 │
└──────────────────────────────────┴────────────────────────┴──────────
─────┘

 Total params: 2,118,341 (8.08 MB)
 Trainable params: 706,113 (2.69 MB)

 Non-trainable params: 0 (0.00 B)

 Optimizer params: 1,412,228 (5.39 MB)

#Evaluating the model
predictions = (model.predict(X_test) > 0.5).astype("int32")
print(classification_report(y_test, predictions))
print('Accuracy:', accuracy_score(y_test, predictions))

10000/10000 ━━━━━━━━━━━━━━━━━━━━ 5366s 537ms/step
              precision    recall  f1-score   support

           0       0.50      1.00      0.67    159494
           1       0.00      0.00      0.00    160506

    accuracy                           0.50    320000
   macro avg       0.25      0.50      0.33    320000
weighted avg       0.25      0.50      0.33    320000

Accuracy: 0.49841875

/opt/anaconda3/lib/python3.11/site-packages/sklearn/metrics/
_classification.py:1344: UndefinedMetricWarning: Precision and F-score
are ill-defined and being set to 0.0 in labels with no predicted
samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/anaconda3/lib/python3.11/site-packages/sklearn/metrics/_classific
ation.py:1344: UndefinedMetricWarning: Precision and F-score are ill-
defined and being set to 0.0 in labels with no predicted samples. Use
`zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/anaconda3/lib/python3.11/site-packages/sklearn/metrics/_classific
ation.py:1344: UndefinedMetricWarning: Precision and F-score are ill-
defined and being set to 0.0 in labels with no predicted samples. Use
`zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))

#Performing Hate Speech Recognition in tweets using GRU

import pandas as pd
import numpy as np
import tensorflow as tf
from tensorflow.keras.preprocessing.text import Tokenizer
from tensorflow.keras.preprocessing.sequence import pad_sequences
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Embedding, GRU, Dense, Dropout
from sklearn.model_selection import train_test_split
from sklearn.metrics import classification_report, accuracy_score
import nltk
```

```
from nltk.corpus import stopwords
import re


#Loading the Sentiment140 dataset
data =
pd.read_csv('/Users/Andrea/Desktop/training.1600000.processed.noemotic
on.csv', encoding='latin-1', header=None)
data.columns = ['target', 'ids', 'date', 'flag', 'user', 'text']


data = data[['target', 'text']]


#Target values mapped to binary (0 = negative, 1 = positive)
#Ignore the neutral tweets (target = 2)
data = data[data['target'] != 2]
data['target'] = data['target'].map({0: 0, 4: 1})


stop_words = set(stopwords.words('english'))

def preprocess_text(text):
    text = re.sub(r'http\S+', '', text)  #Remove URLs
    text = re.sub(r'@\w+', '', text)     #Remove mentions
    text = re.sub(r'#', '', text)        #Remove hashtags
    text = re.sub(r'\d+', '', text)      #Remove numbers
    text = re.sub(r'[^\w\s]', '', text)  #Remove punctuation
    text = text.lower()                  #Lowercase
    text = ' '.join([word for word in text.split() if word not in
stop_words])
    return text

data['cleaned_text'] = data['text'].apply(preprocess_text)

#Tokenize the text
tokenizer = Tokenizer(num_words=10000, oov_token='<OOV>')
tokenizer.fit_on_texts(data['cleaned_text'])
sequences = tokenizer.texts_to_sequences(data['cleaned_text'])

#Pad the sequences
padded_sequences = pad_sequences(sequences, padding='post', maxlen=50)

#Splitting the data
X_train, X_test, y_train, y_test = train_test_split(padded_sequences,
data['target'], test_size=0.2, random_state=42)

#Building the model
model = Sequential()
model.add(Embedding(input_dim=10000, output_dim=64, input_length=50))
model.add(GRU(64, return_sequences=True))
model.add(Dropout(0.2))
model.add(GRU(64))
model.add(Dropout(0.2))
model.add(Dense(1, activation='sigmoid'))
```

```
/opt/anaconda3/lib/python3.11/site-packages/keras/src/layers/core/
embedding.py:90: UserWarning: Argument `input_length` is deprecated.
Just remove it.
  warnings.warn(
```

```
#Complie the model
model.compile(optimizer='adam', loss='binary_crossentropy',
metrics=['accuracy'])

#Training the model
history_1 = model.fit(X_train, y_train, epochs=5,
validation_data=(X_test, y_test), batch_size=42)
```

```
Epoch 1/5
30477/30477 ━━━━━━━━━━━━━━━━━━━━ 696s 23ms/step - accuracy: 0.5003 -
loss: 0.6934 - val_accuracy: 0.4984 - val_loss: 0.6932
Epoch 2/5
30477/30477 ━━━━━━━━━━━━━━━━━━━━ 704s 23ms/step - accuracy: 0.5009 -
loss: 0.6932 - val_accuracy: 0.4984 - val_loss: 0.6932
Epoch 3/5
30477/30477 ━━━━━━━━━━━━━━━━━━━━ 708s 23ms/step - accuracy: 0.5102 -
loss: 0.6889 - val_accuracy: 0.7768 - val_loss: 0.4692
Epoch 4/5
30477/30477 ━━━━━━━━━━━━━━━━━━━━ 714s 23ms/step - accuracy: 0.7821 -
loss: 0.4604 - val_accuracy: 0.7917 - val_loss: 0.4411
Epoch 5/5
30477/30477 ━━━━━━━━━━━━━━━━━━━━ 716s 23ms/step - accuracy: 0.7987 -
loss: 0.4312 - val_accuracy: 0.7956 - val_loss: 0.4351
```

```
model.summary()
```

```
Model: "sequential_1"

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━━━━━┓
┃ Layer (type)                     ┃ Output Shape           ┃
Param # ┃
┡━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━
━━━━━┩
│ embedding_1 (Embedding)          │ (None, 50, 64)         │
640,000 │
├──────────────────────────────────┼────────────────────────┼─────────
─────┤
│ gru (GRU)                        │ (None, 50, 64)         │
24,960 │
├──────────────────────────────────┼────────────────────────┼─────────
```

```
──────┤
│ dropout_2 (Dropout)                 │ (None, 50, 64)          │
0 │
├─────────────────────────────────────┼─────────────────────────┼──────────
──────┤
│ gru_1 (GRU)                         │ (None, 64)              │
24,960 │
├─────────────────────────────────────┼─────────────────────────┼──────────
──────┤
│ dropout_3 (Dropout)                 │ (None, 64)              │
0 │
├─────────────────────────────────────┼─────────────────────────┼──────────
──────┤
│ dense_1 (Dense)                     │ (None, 1)               │
65 │
└─────────────────────────────────────┴─────────────────────────┴──────────
──────┘

 Total params: 2,069,957 (7.90 MB)

 Trainable params: 689,985 (2.63 MB)

 Non-trainable params: 0 (0.00 B)

 Optimizer params: 1,379,972 (5.26 MB)

#Evaluating the model
predictions_1 = (model.predict(X_test) > 0.5).astype("int32")
print(classification_report(y_test, predictions_1))
print('Accuracy:', accuracy_score(y_test, predictions_1))

10000/10000 ━━━━━━━━━━━━━━━━━━━━ 41s 4ms/step
              precision    recall  f1-score   support

           0       0.81      0.78      0.79    159494
           1       0.79      0.81      0.80    160506

    accuracy                           0.80    320000
   macro avg       0.80      0.80      0.80    320000
weighted avg       0.80      0.80      0.80    320000

Accuracy: 0.7956375

#Implementation of Bi-LSTM, Bi-GRU, LSTM Layer for classification of
Sentiment 140 dataset for analysis

from tensorflow.keras.layers import BatchNormalization, Bidirectional
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Embedding, LSTM, Dense, Dropout
from tensorflow.keras.layers import Embedding, GRU, Dense, Dropout
from sklearn.model_selection import train_test_split
```

```python
from sklearn.metrics import classification_report, accuracy_score
import nltk
from nltk.corpus import stopwords
import re

#Build the model
model = Sequential()

#Embedding layer
model.add(Embedding(input_dim=10000, output_dim=128, input_length=50))

#First Bidirectional LSTM layer
model.add(Bidirectional(LSTM(64, return_sequences=True)))
model.add(Dropout(0.3))
model.add(BatchNormalization())

#Second Bidirectional GRU layer
model.add(Bidirectional(GRU(64, return_sequences=True)))
model.add(Dropout(0.3))
model.add(BatchNormalization())

#Third LSTM layer
model.add(LSTM(64))
model.add(Dropout(0.3))

#Dense layer for binary classification
model.add(Dense(1, activation='sigmoid'))

#Compiling the model
model.compile(optimizer='adam', loss='binary_crossentropy',
metrics=['accuracy'])
```

```
/opt/anaconda3/lib/python3.11/site-packages/keras/src/layers/core/
embedding.py:90: UserWarning: Argument `input_length` is deprecated.
Just remove it.
  warnings.warn(
```

```python
#Train the model
history_2 = model.fit(X_train, y_train, epochs=5,
validation_data=(X_test, y_test), batch_size=32)


model.summary()

#Evaluate the model
predictions_3 = (model.predict(X_test) > 0.5).astype("int32")
print(classification_report(y_test, predictions_3))
print('Accuracy:', accuracy_score(y_test, predictions_3))
```

```
Epoch 1/5
40000/40000 ━━━━━━━━━━━━━━━━━━━━ 5752s 144ms/step - accuracy: 0.5004 -
```

```
loss: 0.6937 - val_accuracy: 0.5016 - val_loss: 0.6931
Epoch 2/5
40000/40000 ━━━━━━━━━━━━━━━━━━━━ 2809s 70ms/step - accuracy: 0.5002 -
loss: 0.6932 - val_accuracy: 0.4984 - val_loss: 0.6933
Epoch 3/5
40000/40000 ━━━━━━━━━━━━━━━━━━━━ 2512s 63ms/step - accuracy: 0.4992 -
loss: 0.6932 - val_accuracy: 0.4984 - val_loss: 0.6932
Epoch 4/5
40000/40000 ━━━━━━━━━━━━━━━━━━━━ 2496s 62ms/step - accuracy: 0.5007 -
loss: 0.6932 - val_accuracy: 0.4984 - val_loss: 0.6932
Epoch 5/5
40000/40000 ━━━━━━━━━━━━━━━━━━━━ 2492s 62ms/step - accuracy: 0.4994 -
loss: 0.6932 - val_accuracy: 0.4984 - val_loss: 0.6932

Model: "sequential_2"

┏━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━
━━━━━┓
┃ Layer (type)                    ┃ Output Shape            ┃
Param # ┃
┡━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━
━━━━━┩
│ embedding_2 (Embedding)         │ (32, 50, 128)           │
1,280,000 │
├─────────────────────────────────┼─────────────────────────┼──────────
─────┤
│ bidirectional (Bidirectional)   │ (32, 50, 128)           │
98,816 │
├─────────────────────────────────┼─────────────────────────┼──────────
─────┤
│ dropout_4 (Dropout)             │ (32, 50, 128)           │
0 │
├─────────────────────────────────┼─────────────────────────┼──────────
─────┤
│ batch_normalization             │ (32, 50, 128)           │
512 │
│ (BatchNormalization)            │                         │
│
├─────────────────────────────────┼─────────────────────────┼──────────
─────┤
│ bidirectional_1 (Bidirectional) │ (32, 50, 128)           │
74,496 │
├─────────────────────────────────┼─────────────────────────┼──────────
─────┤
│ dropout_5 (Dropout)             │ (32, 50, 128)           │
0 │
├─────────────────────────────────┼─────────────────────────┼──────────
─────┤
│ batch_normalization_1           │ (32, 50, 128)           │
512 │
```

```
│ (BatchNormalization)                │                         │
│
├─────────────────────────────────────┼─────────────────────────┼──────────
──────┤
│ lstm_3 (LSTM)                       │ (32, 64)                │
49,408 │
├─────────────────────────────────────┼─────────────────────────┼──────────
──────┤
│ dropout_6 (Dropout)                 │ (32, 64)                │
0 │
├─────────────────────────────────────┼─────────────────────────┼──────────
──────┤
│ dense_2 (Dense)                     │ (32, 1)                 │
65 │
└─────────────────────────────────────┴─────────────────────────┴──────────
──────┘

 Total params: 4,510,405 (17.21 MB)

 Trainable params: 1,503,297 (5.73 MB)

 Non-trainable params: 512 (2.00 KB)

 Optimizer params: 3,006,596 (11.47 MB)

10000/10000 ━━━━━━━━━━━━━━━━━━━━ 155s 15ms/step
              precision    recall  f1-score   support

           0       0.50      1.00      0.67    159494
           1       0.00      0.00      0.00    160506

    accuracy                           0.50    320000
   macro avg       0.25      0.50      0.33    320000
weighted avg       0.25      0.50      0.33    320000

Accuracy: 0.49841875

/opt/anaconda3/lib/python3.11/site-packages/sklearn/metrics/
_classification.py:1344: UndefinedMetricWarning: Precision and F-score
are ill-defined and being set to 0.0 in labels with no predicted
samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/anaconda3/lib/python3.11/site-packages/sklearn/metrics/_classific
ation.py:1344: UndefinedMetricWarning: Precision and F-score are ill-
defined and being set to 0.0 in labels with no predicted samples. Use
`zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/anaconda3/lib/python3.11/site-packages/sklearn/metrics/_classific
ation.py:1344: UndefinedMetricWarning: Precision and F-score are ill-
defined and being set to 0.0 in labels with no predicted samples. Use
```

```
`zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

```python
#Implementation of Bi-LSTM , Bi-GRU and Bi-Lstm layer for the
classification of tweets in Sentiment 140 dataset

from tensorflow.keras.layers import BatchNormalization, Bidirectional

#Build the model
model = Sequential()

#Embedding layer
model.add(Embedding(input_dim=10000, output_dim=128, input_length=50))

#First Bidirectional LSTM layer
model.add(Bidirectional(LSTM(64, return_sequences=True)))
model.add(Dropout(0.3))
model.add(BatchNormalization())

#Second Bidirectional GRU layer
model.add(Bidirectional(GRU(64, return_sequences=True)))
model.add(Dropout(0.3))
model.add(BatchNormalization())

#Third Bidirectional LSTM layer
model.add(Bidirectional(LSTM(64)))
model.add(Dropout(0.3))

#Dense layer for binary classification, activation function is sigmoid
model.add(Dense(1, activation='sigmoid'))

#Compiling the model
model.compile(optimizer='adam', loss='binary_crossentropy',
metrics=['accuracy'])
```

```
/opt/anaconda3/lib/python3.11/site-packages/keras/src/layers/core/
embedding.py:90: UserWarning: Argument `input_length` is deprecated.
Just remove it.
  warnings.warn(
```

```python
#Training the model
history_3 = model.fit(X_train, y_train, epochs=5,
validation_data=(X_test, y_test), batch_size=32)


model.summary()

#Evaluate the model
predictions_4 = (model.predict(X_test) > 0.5).astype("int32")
print(classification_report(y_test, predictions_4))
print('Accuracy:', accuracy_score(y_test, predictions_4))
```

```
Epoch 1/5
40000/40000 ━━━━━━━━━━━━━━━━━━━━ 2899s 72ms/step - accuracy: 0.7664 -
loss: 0.4842 - val_accuracy: 0.7906 - val_loss: 0.4463
Epoch 2/5
40000/40000 ━━━━━━━━━━━━━━━━━━━━ 2904s 73ms/step - accuracy: 0.7963 -
loss: 0.4370 - val_accuracy: 0.7944 - val_loss: 0.4406
Epoch 3/5
40000/40000 ━━━━━━━━━━━━━━━━━━━━ 3843s 96ms/step - accuracy: 0.8035 -
loss: 0.4237 - val_accuracy: 0.7955 - val_loss: 0.4374
Epoch 4/5
40000/40000 ━━━━━━━━━━━━━━━━━━━━ 4581s 115ms/step - accuracy: 0.8069 -
loss: 0.4174 - val_accuracy: 0.7963 - val_loss: 0.4379
Epoch 5/5
40000/40000 ━━━━━━━━━━━━━━━━━━━━ 2950s 74ms/step - accuracy: 0.8097 -
loss: 0.4132 - val_accuracy: 0.7944 - val_loss: 0.4390

Model: "sequential_3"

┏━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━
━━━━━┓
┃ Layer (type)                    ┃ Output Shape           ┃
Param # ┃
┡━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━
━━━━━┩
│ embedding_3 (Embedding)         │ (32, 50, 128)          │
1,280,000 │
├─────────────────────────────────┼────────────────────────┼──────────
─────┤
│ bidirectional_2 (Bidirectional) │ (32, 50, 128)          │
98,816 │
├─────────────────────────────────┼────────────────────────┼──────────
─────┤
│ dropout_7 (Dropout)             │ (32, 50, 128)          │
0 │
├─────────────────────────────────┼────────────────────────┼──────────
─────┤
│ batch_normalization_2           │ (32, 50, 128)          │
512 │
│ (BatchNormalization)            │                        │
│
├─────────────────────────────────┼────────────────────────┼──────────
─────┤
│ bidirectional_3 (Bidirectional) │ (32, 50, 128)          │
74,496 │
├─────────────────────────────────┼────────────────────────┼──────────
─────┤
│ dropout_8 (Dropout)             │ (32, 50, 128)          │
0 │
├─────────────────────────────────┼────────────────────────┼──────────
─────┤
```

```
│ batch_normalization_3            │ (32, 50, 128)           │
512 │
│ (BatchNormalization)             │                         │
│
├──────────────────────────────────┼─────────────────────────┼───────────
─────┤
│ bidirectional_4 (Bidirectional) │ (32, 128)               │
98,816 │
├──────────────────────────────────┼─────────────────────────┼───────────
─────┤
│ dropout_9 (Dropout)              │ (32, 128)               │
0 │
├──────────────────────────────────┼─────────────────────────┼───────────
─────┤
│ dense_3 (Dense)                  │ (32, 1)                 │
129 │
└──────────────────────────────────┴─────────────────────────┴───────────
─────┘

 Total params: 4,658,821 (17.77 MB)

 Trainable params: 1,552,769 (5.92 MB)

 Non-trainable params: 512 (2.00 KB)

 Optimizer params: 3,105,540 (11.85 MB)

10000/10000 ━━━━━━━━━━━━━━━━━━━━ 186s 19ms/step
              precision    recall  f1-score   support

           0       0.80      0.78      0.79    159494
           1       0.79      0.81      0.80    160506

    accuracy                           0.79    320000
   macro avg       0.79      0.79      0.79    320000
weighted avg       0.79      0.79      0.79    320000

Accuracy: 0.794375

#Implentation of Bi-LSTM and Bi-GRU model for the sentiment 140
dataset

from tensorflow.keras.layers import BatchNormalization, Bidirectional

model = Sequential()
model.add(Embedding(input_dim=20000, output_dim=128, input_length=50))
model.add(Bidirectional(LSTM(128, return_sequences=True)))
model.add(Dropout(0.2))
model.add(Bidirectional(GRU(128)))
model.add(Dropout(0.2))
model.add(Dense(1, activation='sigmoid'))
```

```
#Compiling the model
model.compile(optimizer='adam', loss='binary_crossentropy',
metrics=['accuracy'])
```

```
/opt/anaconda3/lib/python3.11/site-packages/keras/src/layers/core/
embedding.py:90: UserWarning: Argument `input_length` is deprecated.
Just remove it.
  warnings.warn(
```

```
#Training the model
history_4 = model.fit(X_train, y_train, epochs=5,
validation_data=(X_test, y_test), batch_size=32)


model.summary()

#Evaluate the model
predictions_5 = (model.predict(X_test) > 0.5).astype("int32")
print(classification_report(y_test, predictions_5))
print('Accuracy:', accuracy_score(y_test, predictions_5))
```

```
Epoch 1/5
40000/40000 ━━━━━━━━━━━━━━━━━━━━ 4405s 110ms/step - accuracy: 0.7692 -
loss: 0.4763 - val_accuracy: 0.7942 - val_loss: 0.4390
Epoch 2/5
40000/40000 ━━━━━━━━━━━━━━━━━━━━ 4131s 103ms/step - accuracy: 0.8020 -
loss: 0.4251 - val_accuracy: 0.7990 - val_loss: 0.4300
Epoch 3/5
40000/40000 ━━━━━━━━━━━━━━━━━━━━ 3982s 100ms/step - accuracy: 0.8120 -
loss: 0.4085 - val_accuracy: 0.8000 - val_loss: 0.4315
Epoch 4/5
40000/40000 ━━━━━━━━━━━━━━━━━━━━ 8334s 208ms/step - accuracy: 0.8180 -
loss: 0.3979 - val_accuracy: 0.7836 - val_loss: 0.4523
Epoch 5/5
40000/40000 ━━━━━━━━━━━━━━━━━━━━ 11454s 286ms/step - accuracy: 0.8105
- loss: 0.4105 - val_accuracy: 0.7927 - val_loss: 0.4436

Model: "sequential_4"

┏━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━
━━━━━┓
┃ Layer (type)                     ┃ Output Shape            ┃
Param # ┃
┡━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━
━━━━━┩
│ embedding_4 (Embedding)          │ (32, 50, 128)           │
2,560,000 │
├──────────────────────────────────┼─────────────────────────┼──────────
```

```
──────┤
│ bidirectional_5 (Bidirectional) │ (32, 50, 256)            │
263,168 │
├─────────────────────────────────┼──────────────────────────┼─────────
──────┤
│ dropout_10 (Dropout)            │ (32, 50, 256)            │
0 │
├─────────────────────────────────┼──────────────────────────┼─────────
──────┤
│ bidirectional_6 (Bidirectional) │ (32, 256)                │
296,448 │
├─────────────────────────────────┼──────────────────────────┼─────────
──────┤
│ dropout_11 (Dropout)            │ (32, 256)                │
0 │
├─────────────────────────────────┼──────────────────────────┼─────────
──────┤
│ dense_4 (Dense)                 │ (32, 1)                  │
257 │
└─────────────────────────────────┴──────────────────────────┴─────────
──────┘

 Total params: 9,359,621 (35.70 MB)

 Trainable params: 3,119,873 (11.90 MB)

 Non-trainable params: 0 (0.00 B)

 Optimizer params: 6,239,748 (23.80 MB)

10000/10000 ━━━━━━━━━━━━━━━━━━━━ 241s 24ms/step
              precision    recall  f1-score   support

           0       0.79      0.80      0.79    159494
           1       0.80      0.78      0.79    160506

    accuracy                           0.79    320000
   macro avg       0.79      0.79      0.79    320000
weighted avg       0.79      0.79      0.79    320000

Accuracy: 0.792653125

#Implentation of LSTM on the Davidson Dataset

import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder
from tensorflow.keras.preprocessing.text import Tokenizer
from tensorflow.keras.preprocessing.sequence import pad_sequences
```

```
#Loading the Davidson Dataset
data = pd.read_csv('/Users/Andrea/Desktop/Davidson Dataset.csv')


print(data.head())


   Unnamed: 0  count  hate_speech  offensive_language  neither  class  \
0           0      3            0                   0        3      2

1           1      3            0                   3        0      1

2           2      3            0                   3        0      1

3           3      3            0                   2        1      1

4           4      6            0                   6        0      1


                                               tweet
0  !!! RT @mayasolovely: As a woman you shouldn't...
1  !!!!! RT @mleew17: boy dats cold...tyga dwn ba...
2  !!!!!!! RT @UrKindOfBrand Dawg!!!! RT @80sbaby...
3  !!!!!!!!! RT @C_G_Anderson: @viva_based she lo...
4  !!!!!!!!!!!!! RT @ShenikaRoberts: The shit you...

data.shape

(24783, 7)
```

#Class Labels 0 - hate speech 1 - offensive language 2- neither

```
data.head(5)

   Unnamed: 0  count  hate_speech  offensive_language  neither  class  \
0           0      3            0                   0        3      2

1           1      3            0                   3        0      1

2           2      3            0                   3        0      1

3           3      3            0                   2        1      1

4           4      6            0                   6        0      1


                                               tweet
0  !!! RT @mayasolovely: As a woman you shouldn't...
1  !!!!! RT @mleew17: boy dats cold...tyga dwn ba...
```

```
2  !!!!!!! RT @UrKindOfBrand Dawg!!!! RT @80sbaby...
3  !!!!!!!!! RT @C_G_Anderson: @viva_based she lo...
4  !!!!!!!!!!!!! RT @ShenikaRoberts: The shit you...
```

```
#Selecting the tweet and class column
data = data[['tweet', 'class']]

def preprocess_text(text):
    text = text.lower()
    text = re.sub(r'[^a-zA-Z0-9\s]', '', text)
    text = re.sub(r'\s+', ' ', text).strip()
    return text


data['tweet'] = data['tweet'].apply(preprocess_text)


label_encoder = LabelEncoder()
data['class'] = label_encoder.fit_transform(data['class'])

#Splitting the data
X_train, X_test, y_train, y_test = train_test_split(data['tweet'],
data['class'], test_size=0.2, random_state=42)

#Tokenize the text
tokenizer = Tokenizer(num_words=20000, oov_token="<OOV>")
tokenizer.fit_on_texts(X_train)
X_train_sequences = tokenizer.texts_to_sequences(X_train)
X_test_sequences = tokenizer.texts_to_sequences(X_test)

#Pad the sequences
max_length = 100
X_train_padded = pad_sequences(X_train_sequences, maxlen=max_length,
padding='post', truncating='post')
X_test_padded = pad_sequences(X_test_sequences, maxlen=max_length,
padding='post', truncating='post')

import tensorflow as tf
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Embedding, LSTM, Dense, Dropout

#Build the model
model = Sequential()
model.add(Embedding(input_dim=20000, output_dim=128,
input_length=max_length))
model.add(LSTM(128, return_sequences=True))
model.add(Dropout(0.2))
model.add(LSTM(128))
model.add(Dropout(0.2))
model.add(Dense(3, activation='softmax'))
```

```
#Compiling the model
model.compile(loss='sparse_categorical_crossentropy',
optimizer='adam', metrics=['accuracy'])


#Train the model
history = model.fit(X_train_padded, y_train, epochs=5, batch_size=64,
validation_data=(X_test_padded, y_test))
```

```
Epoch 1/5

/opt/anaconda3/lib/python3.11/site-packages/keras/src/layers/core/
embedding.py:90: UserWarning: Argument `input_length` is deprecated.
Just remove it.
  warnings.warn(

310/310 ━━━━━━━━━━━━━━━━━━━━ 37s 117ms/step - accuracy: 0.7632 - loss:
0.6863 - val_accuracy: 0.7730 - val_loss: 0.6656
Epoch 2/5
310/310 ━━━━━━━━━━━━━━━━━━━━ 36s 117ms/step - accuracy: 0.7783 - loss:
0.6602 - val_accuracy: 0.7730 - val_loss: 0.6680
Epoch 3/5
310/310 ━━━━━━━━━━━━━━━━━━━━ 37s 120ms/step - accuracy: 0.7719 - loss:
0.6694 - val_accuracy: 0.7730 - val_loss: 0.6651
Epoch 4/5
310/310 ━━━━━━━━━━━━━━━━━━━━ 35s 114ms/step - accuracy: 0.7776 - loss:
0.6611 - val_accuracy: 0.7730 - val_loss: 0.6656
Epoch 5/5
310/310 ━━━━━━━━━━━━━━━━━━━━ 36s 116ms/step - accuracy: 0.7726 - loss:
0.6697 - val_accuracy: 0.7730 - val_loss: 0.6665
```

```
model.summary()
```

```
Model: "sequential_9"

┏━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━
━━━━━┓
┃ Layer (type)                     ┃ Output Shape            ┃
Param # ┃
┡━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━
━━━━━┩
│ embedding_9 (Embedding)          │ (None, 100, 128)        │
2,560,000 │
├──────────────────────────────────┼─────────────────────────┼──────────
─────┤
│ lstm_11 (LSTM)                   │ (None, 100, 128)        │
131,584 │
├──────────────────────────────────┼─────────────────────────┼──────────
─────┤
│ dropout_19 (Dropout)             │ (None, 100, 128)        │
0 │
```

```
├─────────────────────────────────┼─────────────────────────┼──────────
──────┤
│ lstm_12 (LSTM)                  │ (None, 128)             │
131,584 │
├─────────────────────────────────┼─────────────────────────┼──────────
──────┤
│ dropout_20 (Dropout)            │ (None, 128)             │
0 │
├─────────────────────────────────┼─────────────────────────┼──────────
──────┤
│ dense_9 (Dense)                 │ (None, 3)               │
387 │
└─────────────────────────────────┴─────────────────────────┴──────────
──────┘

 Total params: 8,470,667 (32.31 MB)

 Trainable params: 2,823,555 (10.77 MB)

 Non-trainable params: 0 (0.00 B)

 Optimizer params: 5,647,112 (21.54 MB)

#Evaluating the model on the test set
loss, accuracy = model.evaluate(X_test_padded, y_test)
print(f'Test Accuracy: {accuracy*100:.2f}%')

155/155 ━━━━━━━━━━━━━━━━━━━━ 3s 22ms/step - accuracy: 0.7743 - loss:
0.6673
Test Accuracy: 77.30%

#Implementating GRU model on the Davidson twitter dataset

import numpy as np
import pandas as pd
import re
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder
from tensorflow.keras.preprocessing.text import Tokenizer
from tensorflow.keras.preprocessing.sequence import pad_sequences
import tensorflow as tf
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Embedding, GRU, Dense, Dropout

#Loading the dataset
data = pd.read_csv('/Users/Andrea/Desktop/Davidson Dataset.csv')


#Using only the tweet and the class column
data = data[['tweet', 'class']]
```

```python
#Performing preprocessing
def preprocess_text(text):
    text = text.lower()
    text = re.sub(r'[^a-zA-Z0-9\s]', '', text)
    text = re.sub(r'\s+', ' ', text).strip()
    return text


data['tweet'] = data['tweet'].apply(preprocess_text)


label_encoder = LabelEncoder()
data['class'] = label_encoder.fit_transform(data['class'])

#Splitting the dataset
X_train, X_test, y_train, y_test = train_test_split(data['tweet'],
data['class'], test_size=0.2, random_state=42)

#Tokenize the text
tokenizer = Tokenizer(num_words=20000, oov_token="<OOV>")
tokenizer.fit_on_texts(X_train)
X_train_sequences = tokenizer.texts_to_sequences(X_train)
X_test_sequences = tokenizer.texts_to_sequences(X_test)

#Padding the sequences
max_length = 100
X_train_padded = pad_sequences(X_train_sequences, maxlen=max_length,
padding='post', truncating='post')
X_test_padded = pad_sequences(X_test_sequences, maxlen=max_length,
padding='post', truncating='post')

#Building the GRU model
model = Sequential()
model.add(Embedding(input_dim=20000, output_dim=128,
input_length=max_length))
model.add(GRU(128, return_sequences=True))
model.add(Dropout(0.2))
model.add(GRU(128))
model.add(Dense(3, activation='softmax'))
```

```
/opt/anaconda3/lib/python3.11/site-packages/keras/src/layers/core/
embedding.py:90: UserWarning: Argument `input_length` is deprecated.
Just remove it.
  warnings.warn(
```

```python
#Compiling the model
model.compile(loss='sparse_categorical_crossentropy',
optimizer='adam', metrics=['accuracy'])

#Training the model
```

```
history = model.fit(X_train_padded, y_train, epochs=5, batch_size=64,
validation_data=(X_test_padded, y_test))


Epoch 1/5
310/310 ━━━━━━━━━━━━━━━━━━━━ 40s 125ms/step - accuracy: 0.7735 - loss:
0.6877 - val_accuracy: 0.7730 - val_loss: 0.6652
Epoch 2/5
310/310 ━━━━━━━━━━━━━━━━━━━━ 41s 132ms/step - accuracy: 0.7807 - loss:
0.6530 - val_accuracy: 0.7730 - val_loss: 0.6658
Epoch 3/5
310/310 ━━━━━━━━━━━━━━━━━━━━ 44s 144ms/step - accuracy: 0.7691 - loss:
0.6759 - val_accuracy: 0.7730 - val_loss: 0.6678
Epoch 4/5
310/310 ━━━━━━━━━━━━━━━━━━━━ 42s 135ms/step - accuracy: 0.7754 - loss:
0.6647 - val_accuracy: 0.7730 - val_loss: 0.6657
Epoch 5/5
310/310 ━━━━━━━━━━━━━━━━━━━━ 43s 140ms/step - accuracy: 0.7747 - loss:
0.6617 - val_accuracy: 0.7730 - val_loss: 0.6698

model.summary()

Model: "sequential_6"

┏━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━
━━━━━┓
┃ Layer (type)                    ┃ Output Shape           ┃
Param # ┃
┡━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━
━━━━━┩
│ embedding_6 (Embedding)         │ (None, 100, 128)       │
2,560,000 │
├─────────────────────────────────┼────────────────────────┼───────
─────┤
│ gru_5 (GRU)                     │ (None, 100, 128)       │
99,072 │
├─────────────────────────────────┼────────────────────────┼───────
─────┤
│ dropout_14 (Dropout)            │ (None, 100, 128)       │
0 │
├─────────────────────────────────┼────────────────────────┼───────
─────┤
│ gru_6 (GRU)                     │ (None, 128)            │
99,072 │
├─────────────────────────────────┼────────────────────────┼───────
─────┤
│ dense_6 (Dense)                 │ (None, 3)              │
387 │
└─────────────────────────────────┴────────────────────────┴───────
─────┘
```

```
 Total params: 8,275,595 (31.57 MB)

 Trainable params: 2,758,531 (10.52 MB)

 Non-trainable params: 0 (0.00 B)

 Optimizer params: 5,517,064 (21.05 MB)

#Evaluating the model
loss, accuracy = model.evaluate(X_test_padded, y_test, verbose=1)
print(f'Test Accuracy: {accuracy}')

155/155 ━━━━━━━━━━━━━━━━━━━━ 3s 22ms/step - accuracy: 0.7743 - loss:
0.6706
Test Accuracy: 0.7730482220649719

#The below code shows the step by step procedure to implement Bi-
directional LSTM and Bi-directional GRU for the Davidson twitter
dataset

import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder
from tensorflow.keras.preprocessing.text import Tokenizer
from tensorflow.keras.preprocessing.sequence import pad_sequences

#Loading the dataset
df = pd.read_csv('/Users/Andrea/Desktop/Davidson Dataset.csv')

#Selecting the tweet and class columns
df= df[['tweet', 'class']]

df.head(5)

                                               tweet  class
0  !!! RT @mayasolovely: As a woman you shouldn't...      2
1  !!!!! RT @mleew17: boy dats cold...tyga dwn ba...      1
2  !!!!!!! RT @UrKindOfBrand Dawg!!!! RT @80sbaby...      1
3  !!!!!!!!! RT @C_G_Anderson: @viva_based she lo...      1
4  !!!!!!!!!!!!! RT @ShenikaRoberts: The shit you...      1

print(data.head())

                                               tweet  class
0  rt mayasolovely as a woman you shouldnt compla...      2
1  rt mleew17 boy dats coldtyga dwn bad for cuffi...      1
2  rt urkindofbrand dawg rt 80sbaby4life you ever...      1
3     rt cganderson vivabased she look like a tranny      1
4  rt shenikaroberts the shit you hear about me m...      1
```

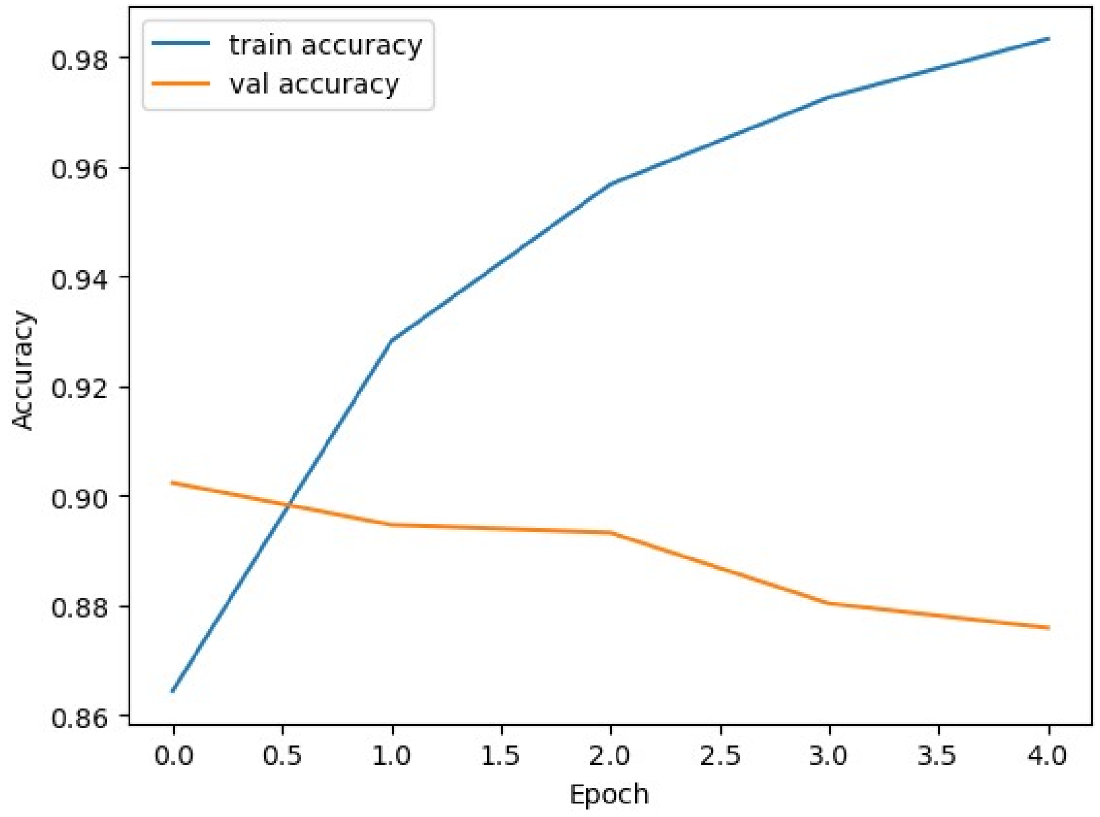
```python
label_encoder = LabelEncoder()
data['class'] = label_encoder.fit_transform(data['class'])

#Splitting the data
X_train, X_test, y_train, y_test = train_test_split(df['tweet'],
df['class'], test_size=0.2, random_state=42)

#Tokenize the text
tokenizer = Tokenizer(num_words=20000, oov_token="<OOV>")
tokenizer.fit_on_texts(X_train)
X_train_sequences = tokenizer.texts_to_sequences(X_train)
X_test_sequences = tokenizer.texts_to_sequences(X_test)

#Pad the sequences
max_length = 100
X_train_padded = pad_sequences(X_train_sequences, maxlen=max_length,
padding='post', truncating='post')
X_test_padded = pad_sequences(X_test_sequences, maxlen=max_length,
padding='post', truncating='post')

#Using the Bi-LSTM and Bi-GRU model for the analysis of twitter hate
speech recognition.

import tensorflow as tf
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Embedding, Bidirectional, LSTM,
GRU, Dense, Dropout

#Defining the Bi-LSTM and Bi-GRU model
model = Sequential()
model.add(Embedding(input_dim=20000, output_dim=128,
input_length=max_length))
model.add(Bidirectional(LSTM(128, return_sequences=True)))
model.add(Dropout(0.2))
model.add(Bidirectional(GRU(128)))
model.add(Dropout(0.2))
model.add(Dense(3, activation='softmax'))
```

```
/opt/anaconda3/lib/python3.11/site-packages/keras/src/layers/core/
embedding.py:90: UserWarning: Argument `input_length` is deprecated.
Just remove it.
  warnings.warn(
```

```python
#Compiling the model
model.compile(loss='sparse_categorical_crossentropy',
optimizer='adam', metrics=['accuracy'])

#Training the model
history = model.fit(X_train_padded, y_train, epochs=5, batch_size=64,
validation_data=(X_test_padded, y_test))
```

```
Epoch 1/5
310/310 ━━━━━━━━━━━━━━━━━━━━ 76s 241ms/step - accuracy: 0.8231 - loss:
0.5061 - val_accuracy: 0.9024 - val_loss: 0.2858
Epoch 2/5
310/310 ━━━━━━━━━━━━━━━━━━━━ 87s 281ms/step - accuracy: 0.9276 - loss:
0.2166 - val_accuracy: 0.8947 - val_loss: 0.3138
Epoch 3/5
310/310 ━━━━━━━━━━━━━━━━━━━━ 87s 280ms/step - accuracy: 0.9573 - loss:
0.1237 - val_accuracy: 0.8933 - val_loss: 0.3579
Epoch 4/5
310/310 ━━━━━━━━━━━━━━━━━━━━ 86s 278ms/step - accuracy: 0.9754 - loss:
0.0717 - val_accuracy: 0.8804 - val_loss: 0.5300
Epoch 5/5
310/310 ━━━━━━━━━━━━━━━━━━━━ 87s 280ms/step - accuracy: 0.9851 - loss:
0.0473 - val_accuracy: 0.8759 - val_loss: 0.5109

model.summary()

Model: "sequential_7"

┏━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━
━━━━━┓
┃ Layer (type)                    ┃ Output Shape           ┃
Param # ┃
┡━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━
━━━━━┩
│ embedding_7 (Embedding)         │ (None, 100, 128)       │
2,560,000 │
├─────────────────────────────────┼────────────────────────┼──────────
─────┤
│ bidirectional_7 (Bidirectional) │ (None, 100, 256)       │
263,168 │
├─────────────────────────────────┼────────────────────────┼──────────
─────┤
│ dropout_15 (Dropout)            │ (None, 100, 256)       │
0 │
├─────────────────────────────────┼────────────────────────┼──────────
─────┤
│ bidirectional_8 (Bidirectional) │ (None, 256)            │
296,448 │
├─────────────────────────────────┼────────────────────────┼──────────
─────┤
│ dropout_16 (Dropout)            │ (None, 256)            │
0 │
├─────────────────────────────────┼────────────────────────┼──────────
─────┤
│ dense_7 (Dense)                 │ (None, 3)              │
771 │
└─────────────────────────────────┴────────────────────────┴──────────
─────┘
```

```
 Total params: 9,361,163 (35.71 MB)

 Trainable params: 3,120,387 (11.90 MB)

 Non-trainable params: 0 (0.00 B)

 Optimizer params: 6,240,776 (23.81 MB)

#Evaluating the model on test set
loss, accuracy = model.evaluate(X_test_padded, y_test)
print(f'Test Accuracy: {accuracy*100:.2f}%')

155/155 ━━━━━━━━━━━━━━━━━━━━ 8s 52ms/step - accuracy: 0.8785 - loss:
0.5171
Test Accuracy: 87.59%

import matplotlib.pyplot as plt

plt.plot(history.history['accuracy'], label='train accuracy')
plt.plot(history.history['val_accuracy'], label='val accuracy')
plt.xlabel('Epoch')
plt.ylabel('Accuracy')
plt.legend()
plt.show()
```



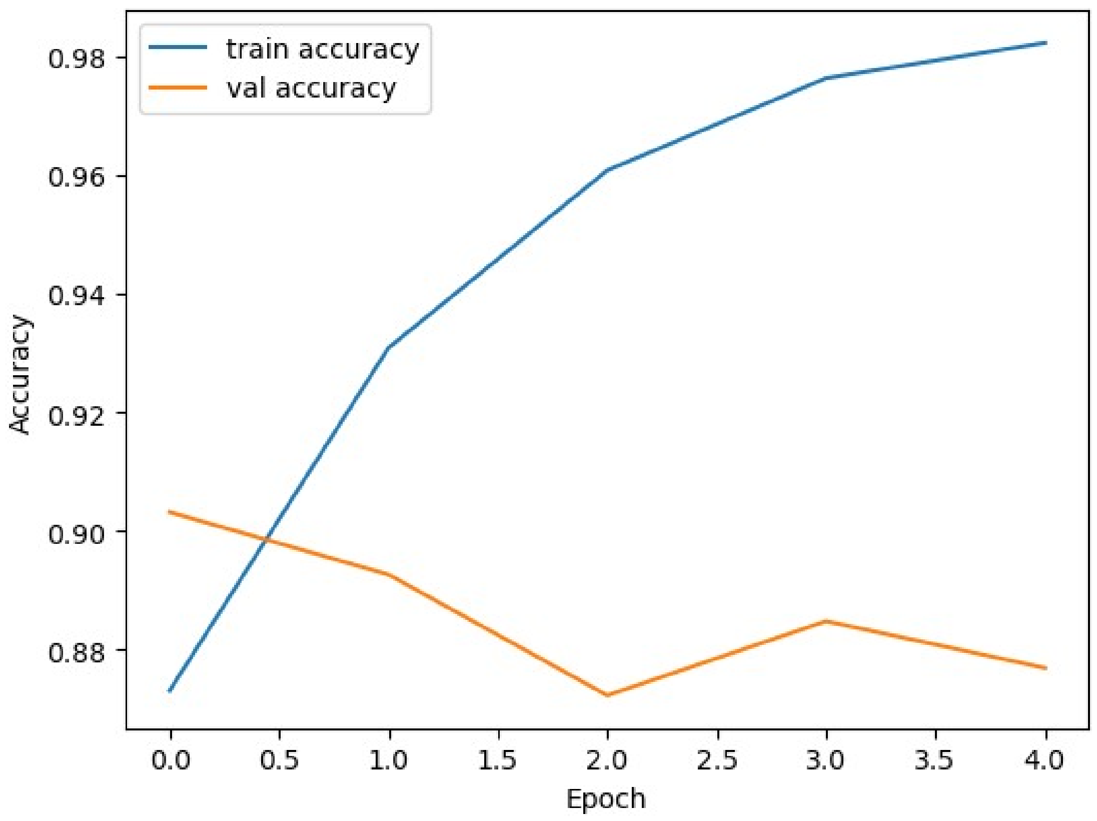
```python
#This part of the code below has batch size = 32 and length if the
tweet = 25

label_encoder = LabelEncoder()
data['class'] = label_encoder.fit_transform(data['class'])

#Splitting the data
X_train, X_test, y_train, y_test = train_test_split(df['tweet'],
df['class'], test_size=0.2, random_state=42)

#Tokenize the text
tokenizer = Tokenizer(num_words=20000, oov_token="<OOV>")
tokenizer.fit_on_texts(X_train)
X_train_sequences = tokenizer.texts_to_sequences(X_train)
X_test_sequences = tokenizer.texts_to_sequences(X_test)

#Pad the sequences
max_length = 25
X_train_padded = pad_sequences(X_train_sequences, maxlen=max_length,
padding='post', truncating='post')
X_test_padded = pad_sequences(X_test_sequences, maxlen=max_length,
padding='post', truncating='post')

#Using the Bi-LSTM and Bi-GRU model for the analysis of twitter hate
speech recognition.

import tensorflow as tf
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Embedding, Bidirectional, LSTM,
GRU, Dense, Dropout

#Define the Bi-LSTM and Bi-GRU model
model = Sequential()
model.add(Embedding(input_dim=20000, output_dim=128,
input_length=max_length))
model.add(Bidirectional(LSTM(128, return_sequences=True)))
model.add(Dropout(0.2))
model.add(Bidirectional(GRU(128)))
model.add(Dropout(0.2))
model.add(Dense(3, activation='softmax'))
```

```
/opt/anaconda3/lib/python3.11/site-packages/keras/src/layers/core/
embedding.py:90: UserWarning: Argument `input_length` is deprecated.
Just remove it.
  warnings.warn(
```

```python
#Compiling the model
model.compile(loss='sparse_categorical_crossentropy',
optimizer='adam', metrics=['accuracy'])
```

```
#Training the model
history = model.fit(X_train_padded, y_train, epochs=5, batch_size=32,
validation_data=(X_test_padded, y_test))


Epoch 1/5
620/620 ━━━━━━━━━━━━━━━━━━━━ 33s 51ms/step - accuracy: 0.8379 - loss:
0.4772 - val_accuracy: 0.9032 - val_loss: 0.2810
Epoch 2/5
620/620 ━━━━━━━━━━━━━━━━━━━━ 36s 57ms/step - accuracy: 0.9334 - loss:
0.1982 - val_accuracy: 0.8927 - val_loss: 0.2988
Epoch 3/5
620/620 ━━━━━━━━━━━━━━━━━━━━ 36s 58ms/step - accuracy: 0.9636 - loss:
0.1115 - val_accuracy: 0.8723 - val_loss: 0.4364
Epoch 4/5
620/620 ━━━━━━━━━━━━━━━━━━━━ 36s 59ms/step - accuracy: 0.9777 - loss:
0.0671 - val_accuracy: 0.8848 - val_loss: 0.4227
Epoch 5/5
620/620 ━━━━━━━━━━━━━━━━━━━━ 35s 57ms/step - accuracy: 0.9850 - loss:
0.0453 - val_accuracy: 0.8769 - val_loss: 0.5011

model.summary()

Model: "sequential_8"

┏━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━
━━━━━┓
┃ Layer (type)                     ┃ Output Shape            ┃
Param # ┃
┡━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━
━━━━━┩
│ embedding_8 (Embedding)          │ (None, 25, 128)         │
2,560,000 │
├──────────────────────────────────┼─────────────────────────┼──────────
─────┤
│ bidirectional_9 (Bidirectional)  │ (None, 25, 256)         │
263,168 │
├──────────────────────────────────┼─────────────────────────┼──────────
─────┤
│ dropout_17 (Dropout)             │ (None, 25, 256)         │
0 │
├──────────────────────────────────┼─────────────────────────┼──────────
─────┤
│ bidirectional_10                 │ (None, 256)             │
296,448 │
│ (Bidirectional)                  │                         │
│
├──────────────────────────────────┼─────────────────────────┼──────────
─────┤
│ dropout_18 (Dropout)             │ (None, 256)             │
```

```
0 │
├─────────────────────────────────┼────────────────────────┼──────────
──────┤
│ dense_8 (Dense)                 │ (None, 3)              │
771 │
└─────────────────────────────────┴────────────────────────┴──────────
──────┘

 Total params: 9,361,163 (35.71 MB)

 Trainable params: 3,120,387 (11.90 MB)

 Non-trainable params: 0 (0.00 B)

 Optimizer params: 6,240,776 (23.81 MB)

#Evaluating the model on the test set
loss, accuracy = model.evaluate(X_test_padded, y_test)
print(f'Test Accuracy: {accuracy*100:.2f}%')

155/155 ━━━━━━━━━━━━━━━━━━━━ 2s 12ms/step - accuracy: 0.8784 - loss:
0.5116
Test Accuracy: 87.69%

import matplotlib.pyplot as plt

plt.plot(history.history['accuracy'], label='train accuracy')
plt.plot(history.history['val_accuracy'], label='val accuracy')
plt.xlabel('Epoch')
plt.ylabel('Accuracy')
plt.legend()
plt.show()
```


train accuracy
val accuracy
Accuracy
Epoch
0.98
0.96
0.94
0.92
0.90
0.88
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0