

AI_Phase4

October 20, 2023

Build an NLP model to differentiate real news from fake news

Phase 4: Development Part 2 .

In this part you will continue building your project.

Continue building the fake news detection model by applying NLP techniques and training a classification model.

Text Preprocessing and Feature Extraction

Model training and evaluation

Dataset Link: <https://www.kaggle.com/datasets/clmentbisailon/fake-and-real-news-dataset>

So, Phase 4 continues the development that began in Phase 3, Part 1, where we further enhance the fake news detection model. This involves applying NLP techniques and training a classification model. We've already done applying NLP techniques in phase 3, so we continue in training our model. If you want to read through steps involved in applying NLP techniques jump to Preprocessing the textual data or else,

Jump to continuation of phase 3 (Phase 4)

Model Training (pg. 12)

Evaluation (pg. 14)

Importing required libraries

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

```
[4]: import numpy as np
      import pandas as pd
      import matplotlib.pyplot as plt
      import seaborn as sns

      import nltk
      import re
      import string

      from sklearn.model_selection import train_test_split
```

```

from sklearn.metrics import classification_report

import keras
from keras.preprocessing import text, sequence
from keras.models import Sequential
from keras.layers import Dense, Embedding, LSTM, Dropout

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

```

2023-10-15 16:27:23.172675: I tensorflow/core/util/port.cc:111] oneDNN custom operations are on. You may see slightly different numerical results due to floating-point round-off errors from different computation orders. To turn them off, set the environment variable `TF_ENABLE_ONEDNN_OPTS=0`.

2023-10-15 16:27:23.380239: E tensorflow/compiler/xla/stream_executor/cuda/cuda_dnn.cc:9342] Unable to register cuDNN factory: Attempting to register factory for plugin cuDNN when one has already been registered

2023-10-15 16:27:23.380269: E tensorflow/compiler/xla/stream_executor/cuda/cuda_fft.cc:609] Unable to register cuFFT factory: Attempting to register factory for plugin cuFFT when one has already been registered

2023-10-15 16:27:23.380945: E tensorflow/compiler/xla/stream_executor/cuda/cuda_blas.cc:1518] Unable to register cuBLAS factory: Attempting to register factory for plugin cuBLAS when one has already been registered

2023-10-15 16:27:23.464522: I tensorflow/core/platform/cpu_feature_guard.cc:182] This TensorFlow binary is optimized to use available CPU instructions in performance-critical operations.
To enable the following instructions: AVX2 AVX512F AVX512_VNNI FMA, in other operations, rebuild TensorFlow with the appropriate compiler flags.

2023-10-15 16:27:24.306371: W tensorflow/compiler/tf2tensorrt/utils/py_utils.cc:38] TF-TRT Warning: Could not find TensorRT

dataset/Fake.csv
dataset/archive(1).zip
dataset/True.csv

Loading Data

```
[5]: real_data = pd.read_csv('dataset/True.csv')
     fake_data = pd.read_csv('dataset/Fake.csv')
```

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

```
[6]:                                     title \
0 As U.S. budget fight looms, Republicans flip t...
1 U.S. military to accept transgender recruits o...
2 Senior U.S. Republican senator: 'Let Mr. Muell...
3 FBI Russia probe helped by Australian diplomat...
4 Trump wants Postal Service to charge 'much mor...

                                     text      subject \
0 WASHINGTON (Reuters) - The head of a conservat... politicsNews
1 WASHINGTON (Reuters) - Transgender people will... politicsNews
2 WASHINGTON (Reuters) - The special counsel inv... politicsNews
3 WASHINGTON (Reuters) - Trump campaign adviser ... politicsNews
4 SEATTLE/WASHINGTON (Reuters) - President Donal... politicsNews

                                     date
0 December 31, 2017
1 December 29, 2017
2 December 31, 2017
3 December 30, 2017
4 December 29, 2017
```

```
[7]: fake_data.head()
```

```
[7]:                                     title \
0 Donald Trump Sends Out Embarrassing New Year'...
1 Drunk Bragging Trump Staffer Started Russian ...
2 Sheriff David Clarke Becomes An Internet Joke...
3 Trump Is So Obsessed He Even Has Obama's Name...
4 Pope Francis Just Called Out Donald Trump Dur...

                                     text subject \
0 Donald Trump just couldn t wish all Americans ... News
1 House Intelligence Committee Chairman Devin Nu... News
2 On Friday, it was revealed that former Milwauk... News
3 On Christmas day, Donald Trump announced that ... News
4 Pope Francis used his annual Christmas Day mes... News

                                     date
0 December 31, 2017
1 December 31, 2017
2 December 30, 2017
3 December 29, 2017
4 December 25, 2017
```

```
[8]: #add column
real_data['target'] = 1
fake_data['target'] = 0
```

```
[9]: real_data.tail()
```

```
[9]:                                     title \
21412  'Fully committed' NATO backs new U.S. approach...
21413  LexisNexis withdrew two products from Chinese ...
21414  Minsk cultural hub becomes haven from authorities
21415  Vatican upbeat on possibility of Pope Francis ...
21416  Indonesia to buy $1.14 billion worth of Russia...

                                     text      subject \
21412  BRUSSELS (Reuters) - NATO allies on Tuesday we...  worldnews
21413  LONDON (Reuters) - LexisNexis, a provider of l...  worldnews
21414  MINSK (Reuters) - In the shadow of disused Sov...  worldnews
21415  MOSCOW (Reuters) - Vatican Secretary of State ...  worldnews
21416  JAKARTA (Reuters) - Indonesia will buy 11 Sukh...  worldnews

                                     date  target
21412  August 22, 2017          1
21413  August 22, 2017          1
21414  August 22, 2017          1
21415  August 22, 2017          1
21416  August 22, 2017          1
```

```
[10]: #Merging the 2 datasets
data = pd.concat([real_data, fake_data], ignore_index=True, sort=False)
data.head()
```

```
[10]:                                     title \
0  As U.S. budget fight looms, Republicans flip t...
1  U.S. military to accept transgender recruits o...
2  Senior U.S. Republican senator: 'Let Mr. Muell...
3  FBI Russia probe helped by Australian diplomat...
4  Trump wants Postal Service to charge 'much mor...

                                     text      subject \
0  WASHINGTON (Reuters) - The head of a conservat...  politicsNews
1  WASHINGTON (Reuters) - Transgender people will...  politicsNews
2  WASHINGTON (Reuters) - The special counsel inv...  politicsNews
3  WASHINGTON (Reuters) - Trump campaign adviser ...  politicsNews
4  SEATTLE/WASHINGTON (Reuters) - President Donal...  politicsNews

                                     date  target
0  December 31, 2017          1
1  December 29, 2017          1
2  December 31, 2017          1
3  December 30, 2017          1
4  December 29, 2017          1
```

```
[11]: data.isnull().sum()
```

```
[11]: title      0
      text      0
      subject   0
      date      0
      target     0
      dtype: int64
```

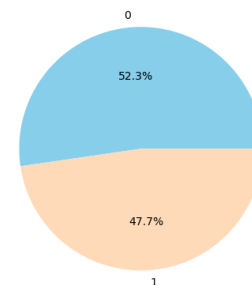
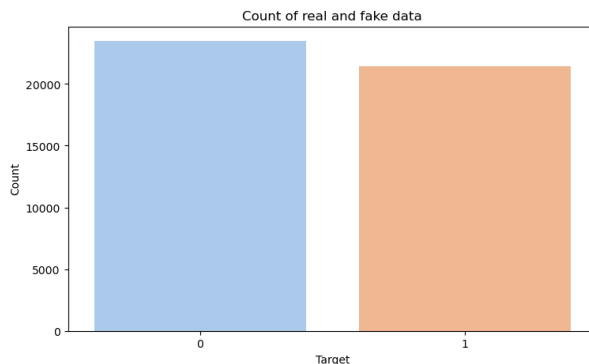
1.Count of Fake and Real Data

```
[12]: print(data["target"].value_counts())
fig, ax = plt.subplots(1,2, figsize=(19, 5))
g1 = sns.countplot(data.target,ax=ax[0],palette="pastel");
g1.set_title("Count of real and fake data")
g1.set_ylabel("Count")
g1.set_xlabel("Target")
g2 = plt.pie(data["target"].value_counts().values,explode=[0,0],labels=data.
    ↪target.value_counts().index, autopct='%1.
    ↪1f%%',colors=['SkyBlue','PeachPuff'])
fig.show()
```

```
0    23481
```

```
1    21417
```

```
Name: target, dtype: int64
```



2.Distribution of The Subject According to Real and Fake Data

```
[13]: print(data.subject.value_counts())
plt.figure(figsize=(10, 5))

ax = sns.countplot(x="subject", hue='target', data=data, palette="pastel")
plt.title("Distribution of The Subject According to Real and Fake Data")
```

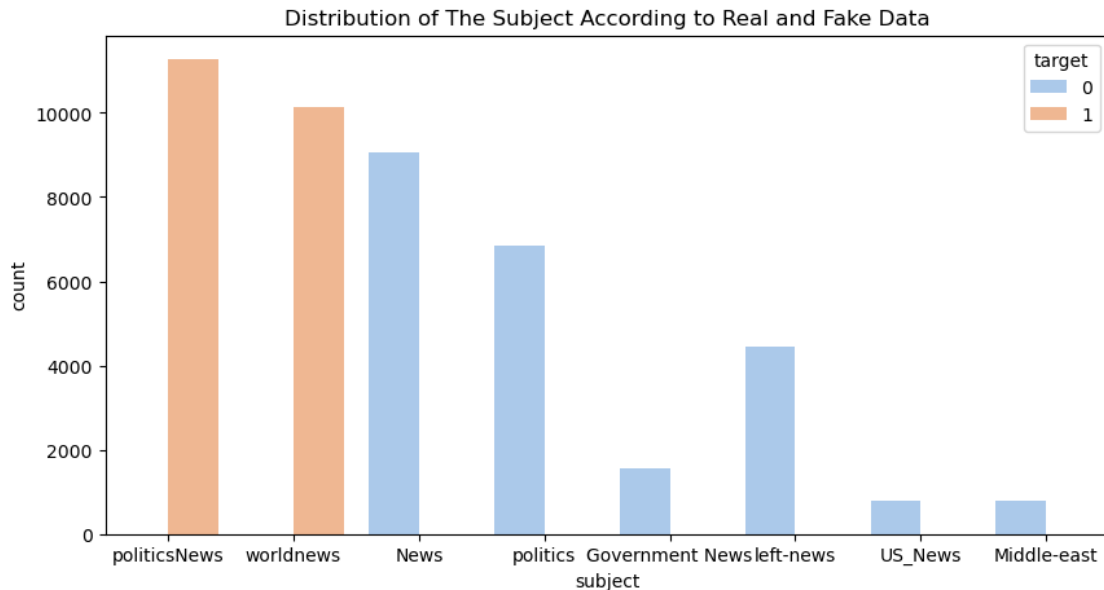
```
politicsNews    11272
worldnews       10145
```

```

News          9050
politics      6841
left-news     4459
Government News 1570
US_News       783
Middle-east   778
Name: subject, dtype: int64

```

```
[13]: Text(0.5, 1.0, 'Distribution of The Subject According to Real and Fake Data')
```



Preprocessing the textual data

```
[14]: data['text'] = data['subject'] + " " + data['title'] + " " + data['text']
      del data['title']
      del data['subject']
      del data['date']
      data.head()
```

```
[14]:
```

	subject	title	text	target
0	politicsNews	As U.S. budget fight looms, Repub...	politicsNews As U.S. budget fight looms, Repub...	1
1	politicsNews	U.S. military to accept transgend...	politicsNews U.S. military to accept transgend...	1
2	politicsNews	Senior U.S. Republican senator: '...	politicsNews Senior U.S. Republican senator: '...	1
3	politicsNews	FBI Russia probe helped by Austra...	politicsNews FBI Russia probe helped by Austra...	1
4	politicsNews	Trump wants Postal Service to cha...	politicsNews Trump wants Postal Service to cha...	1

```
[15]: first_text = data.text[10]
      first_text
```

[15]: 'politicsNews Jones certified U.S. Senate winner despite Moore challenge (Reuters) - Alabama officials on Thursday certified Democrat Doug Jones the winner of the state's U.S. Senate race, after a state judge denied a challenge by Republican Roy Moore, whose campaign was derailed by accusations of sexual misconduct with teenage girls. Jones won the vacant seat by about 22,000 votes, or 1.6 percentage points, election officials said. That made him the first Democrat in a quarter of a century to win a Senate seat in Alabama. The seat was previously held by Republican Jeff Sessions, who was tapped by U.S. President Donald Trump as attorney general. A state canvassing board composed of Alabama Secretary of State John Merrill, Governor Kay Ivey and Attorney General Steve Marshall certified the election results. Seating Jones will narrow the Republican majority in the Senate to 51 of 100 seats. In a statement, Jones called his victory "a new chapter" and pledged to work with both parties. Moore declined to concede defeat even after Trump urged him to do so. He stood by claims of a fraudulent election in a statement released after the certification and said he had no regrets, media outlets reported. An Alabama judge denied Moore's request to block certification of the results of the Dec. 12 election in a decision shortly before the canvassing board met. Moore's challenge alleged there had been potential voter fraud that denied him a chance of victory. His filing on Wednesday in the Montgomery Circuit Court sought to halt the meeting scheduled to ratify Jones' win on Thursday. Moore could ask for a recount, in addition to possible other court challenges, Merrill said in an interview with Fox News Channel. He would have to complete paperwork "within a timed period" and show he has the money for a challenge, Merrill said. "We've not been notified yet of their intention to do that," Merrill said. Regarding the claim of voter fraud, Merrill told CNN that more than 100 cases had been reported. "We've adjudicated more than 60 of those. We will continue to do that," he said. Republican lawmakers in Washington had distanced themselves from Moore and called for him to drop out of the race after several women accused him of sexual assault or misconduct dating back to when they were teenagers and he was in his early 30s. Moore has denied wrongdoing and Reuters has not been able to independently verify the allegations. '

First, let's remove HTML content.

```
[16]: from bs4 import BeautifulSoup

soup = BeautifulSoup(first_text, "html.parser")
first_text = soup.get_text()
first_text
```

[16]: 'politicsNews Jones certified U.S. Senate winner despite Moore challenge (Reuters) - Alabama officials on Thursday certified Democrat Doug Jones the winner of the state's U.S. Senate race, after a state judge denied a challenge by Republican Roy Moore, whose campaign was derailed by accusations of sexual misconduct with teenage girls. Jones won the vacant seat by about 22,000 votes, or 1.6 percentage points, election officials said. That made him the first Democrat in a quarter of a century to win a Senate seat in Alabama. The seat

was previously held by Republican Jeff Sessions, who was tapped by U.S. President Donald Trump as attorney general. A state canvassing board composed of Alabama Secretary of State John Merrill, Governor Kay Ivey and Attorney General Steve Marshall certified the election results. Seating Jones will narrow the Republican majority in the Senate to 51 of 100 seats. In a statement, Jones called his victory "a new chapter" and pledged to work with both parties. Moore declined to concede defeat even after Trump urged him to do so. He stood by claims of a fraudulent election in a statement released after the certification and said he had no regrets, media outlets reported. An Alabama judge denied Moore's request to block certification of the results of the Dec. 12 election in a decision shortly before the canvassing board met. Moore's challenge alleged there had been potential voter fraud that denied him a chance of victory. His filing on Wednesday in the Montgomery Circuit Court sought to halt the meeting scheduled to ratify Jones' win on Thursday. Moore could ask for a recount, in addition to possible other court challenges, Merrill said in an interview with Fox News Channel. He would have to complete paperwork "within a timed period" and show he has the money for a challenge, Merrill said. "We've not been notified yet of their intention to do that," Merrill said. Regarding the claim of voter fraud, Merrill told CNN that more than 100 cases had been reported. "We've adjudicated more than 60 of those. We will continue to do that," he said. Republican lawmakers in Washington had distanced themselves from Moore and called for him to drop out of the race after several women accused him of sexual assault or misconduct dating back to when they were teenagers and he was in his early 30s. Moore has denied wrongdoing and Reuters has not been able to independently verify the allegations. '

Let's now remove everything except uppercase / lowercase letters using Regular Expressions.

```
[17]: first_text = re.sub('\[[^\]]*\', ' ', first_text)
first_text = re.sub('[^a-zA-Z]', ' ', first_text) # replaces non-alphabets with
↳ spaces
first_text = first_text.lower() # Converting from uppercase to lowercase
first_text
```

```
[17]: 'politicsnews jones certified u s senate winner despite moore challenge
reuters alabama officials on thursday certified democrat doug jones the
winner of the state s u s senate race after a state judge denied a challenge
by republican roy moore whose campaign was derailed by accusations of sexual
misconduct with teenage girls jones won the vacant seat by about votes
or percentage points election officials said that made him the first
democrat in a quarter of a century to win a senate seat in alabama the seat
was previously held by republican jeff sessions who was tapped by u s
president donald trump as attorney general a state canvassing board composed of
alabama secretary of state john merrill governor kay ivey and attorney general
steve marshall certified the election results seating jones will narrow the
republican majority in the senate to of seats in a statement jones
called his victory a new chapter and pledged to work with both parties moore
```


declined to concede defeat even after trump urged him to do so he stood by claims of a fraudulent election in a statement released after the certification and said he had no regrets media outlets reported an alabama judge denied moore s request to block certification of the results of the dec election in a decision shortly before the canvassing board met moore s challenge alleged there had been potential voter fraud that denied him a chance of victory his filing on wednesday in the montgomery circuit court sought to halt the meeting scheduled to ratify jones win on thursday moore could ask for a recount in addition to possible other court challenges merrill said in an interview with fox news channel he would have to complete paperwork within a timed period and show he has the money for a challenge merrill said we ve not been notified yet of their intention to do that merrill said regarding the claim of voter fraud merrill told cnn that more than cases had been reported we ve adjudicated more than of those we will continue to do that he said republican lawmakers in washington had distanced themselves from moore and called for him to drop out of the race after several women accused him of sexual assault or misconduct dating back to when they were teenagers and he was in his early s moore has denied wrongdoing and reuters has not been able to independently verify the allegations '

Let's remove stopwords like is,a,the... Which do not offer much insight.

```
[18]: nltk.download("stopwords")
      from nltk.corpus import stopwords

      # we can use tokenizer instead of split
      first_text = nltk.word_tokenize(first_text)
```

[nltk_data] Downloading package stopwords to /home/djoe/nltk_data...

[nltk_data] Package stopwords is already up-to-date!

```
[19]: first_text = [ word for word in first_text if not word in set(stopwords.
      ↪words("english"))]
```

Lemmatization to bring back multiple forms of same word to their common root like 'coming', 'comes' into 'come'.

```
[20]: lemma = nltk.WordNetLemmatizer()
      first_text = [ lemma.lemmatize(word) for word in first_text]

      first_text = " ".join(first_text)
      first_text
```

```
[20]: 'politicsnews jones certified u senate winner despite moore challenge reuters
alabama official thursday certified democrat doug jones winner state u senate
race state judge denied challenge republican roy moore whose campaign derailed
accusation sexual misconduct teenage girl jones vacant seat vote percentage
point election official said made first democrat quarter century win senate seat
alabama seat previously held republican jeff session tapped u president donald
```

trump attorney general state canvassing board composed alabama secretary state john merrill governor kay ivey attorney general steve marshall certified election result seating jones narrow republican majority senate seat statement jones called victory new chapter pledged work party moore declined concede defeat even trump urged stood claim fraudulent election statement released certification said regret medium outlet reported alabama judge denied moore request block certification result dec election decision shortly canvassing board met moore challenge alleged potential voter fraud denied chance victory filing wednesday montgomery circuit court sought halt meeting scheduled ratify jones win thursday moore could ask recount addition possible court challenge merrill said interview fox news channel would complete paperwork within timed period show money challenge merrill said notified yet intention merrill said regarding claim voter fraud merrill told cnn case reported adjudicated continue said republican lawmaker washington distanced moore called drop race several woman accused sexual assault misconduct dating back teenager early moore denied wrongdoing reuters able independently verify allegation'

Performing it for all the examples in the data.

```
[21]: #Removal of HTML Contents
def remove_html(text):
    soup = BeautifulSoup(text, "html.parser")
    return soup.get_text()

#Removal of Punctuation Marks
def remove_punctuations(text):
    return re.sub('\[[^\]]*\]', '', text)

# Removal of Special Characters
def remove_characters(text):
    return re.sub("[^a-zA-Z]", " ", text)

#Removal of stopwords
def remove_stopwords_and_lemmatization(text):
    final_text = []
    text = text.lower()
    text = nltk.word_tokenize(text)

    for word in text:
        if word not in set(stopwords.words('english')):
            lemma = nltk.WordNetLemmatizer()
            word = lemma.lemmatize(word)
            final_text.append(word)
    return " ".join(final_text)

#Total function
def cleaning(text):
```

```
#Apply function on text column
```

```
[22]:
```

	text	target
0	politicsnews u budget fight loom republican fl...	1
1	politicsnews u military accept transgender rec...	1
2	politicsnews senior u republican senator let m...	1
3	politicsnews fbi russia probe helped australia...	1
4	politicsnews trump want postal service charge ...	1

```
[23]: X_train, X_test, y_train, y_test = train_test_split(data['text'],
    data['target'], random_state=0)
```

```
[24]: max_features = 10000
      maxlen = 300
```

```
[26]: tokenized_test = tokenizer.texts_to_sequences(X_test)
      X_test = sequence.pad_sequences(tokenized_test, maxlen=maxlen)
```

[27]: (10101900, 3367500)

[illegible]

```

0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 133, 192, 1,
612, 1520, 1575, 1477, 17, 4359, 873, 3351, 1, 17, 1520,
1575, 1477, 2439, 343, 583, 1205, 182, 3466, 207, 15, 1355,
274, 2766, 2626, 2369, 2866, 149, 3, 99, 1515, 2977, 932,
2, 689, 1754, 153, 4468, 529, 2701, 1477, 2, 207, 308,
1845, 321, 666, 17, 6085, 1477, 32, 11, 9895, 5786, 873,
1, 95, 2, 1675, 3271, 1037, 3466, 211, 432, 503, 45,
7, 3805, 240, 2436, 493, 868, 240, 5870, 2, 147, 2766,
2, 859, 619], dtype=int32)

```

Training Model

```

[29]: # Define key parameters for a machine learning model
batch_size = 256 # Number of data samples processed in each step
epochs = 10 # Number of complete passes through the dataset
embed_size = 100 # Dimensionality of word embeddings

[30]: # Create a sequential neural network model
model = Sequential()

# Add a non-trainable embedding layer
model.add(Embedding(max_features, output_dim=embed_size, input_length=maxlen,
    ↪ trainable=False))

# Add two LSTM layers with specific configurations
model.add(LSTM(units=128, return_sequences=True, recurrent_dropout=0.25,
    ↪ dropout=0.25))
model.add(LSTM(units=64, recurrent_dropout=0.1, dropout=0.1))

# Add two fully connected (Dense) layers with ReLU and sigmoid activations
model.add(Dense(units=32, activation='relu'))
model.add(Dense(1, activation='sigmoid'))

# Compile the model with specific settings

```

```
model.compile(optimizer=keras.optimizers.Adam(lr=0.01),  
              loss='binary_crossentropy', metrics=['accuracy'])
```

```
2023-10-15 16:43:16.811302: I  
tensorflow/compiler/xla/stream_executor/cuda/cuda_diagnostics.cc:168] retrieving  
CUDA diagnostic information for host: djoe  
2023-10-15 16:43:16.811325: I  
tensorflow/compiler/xla/stream_executor/cuda/cuda_diagnostics.cc:175] hostname:  
djoe  
2023-10-15 16:43:16.811421: I  
tensorflow/compiler/xla/stream_executor/cuda/cuda_diagnostics.cc:199] libcuda  
reported version is: NOT_FOUND: was unable to find libcuda.so DSO loaded into  
this program  
2023-10-15 16:43:16.811449: I  
tensorflow/compiler/xla/stream_executor/cuda/cuda_diagnostics.cc:203] kernel  
reported version is: 525.105.17  
WARNING:absl:`lr` is deprecated in Keras optimizer, please use `learning_rate`  
or use the legacy optimizer, e.g., tf.keras.optimizers.legacy.Adam.
```

[31]: `model.summary()`

Model: "sequential"

Layer (type)	Output Shape	Param #
embedding (Embedding)	(None, 300, 100)	1000000
lstm (LSTM)	(None, 300, 128)	117248
lstm_1 (LSTM)	(None, 64)	49408
dense (Dense)	(None, 32)	2080
dense_1 (Dense)	(None, 1)	33

```
=====  
Total params: 1168769 (4.46 MB)  
Trainable params: 168769 (659.25 KB)  
Non-trainable params: 1000000 (3.81 MB)  
=====
```

[32]: `history = model.fit(X_train, y_train, validation_split=0.3, epochs=10,
 batch_size=batch_size, shuffle=True, verbose = 1)`

```
Epoch 1/10  
93/93 [=====] - 91s 935ms/step - loss: 0.5028 -  
accuracy: 0.7535 - val_loss: 0.4817 - val_accuracy: 0.8149  
Epoch 2/10  
93/93 [=====] - 86s 929ms/step - loss: 0.6644 -
```

```

accuracy: 0.6189 - val_loss: 0.5567 - val_accuracy: 0.6679
Epoch 3/10
93/93 [=====] - 87s 932ms/step - loss: 0.4758 -
accuracy: 0.7617 - val_loss: 1.5183 - val_accuracy: 0.6048
Epoch 4/10
93/93 [=====] - 87s 937ms/step - loss: 0.5428 -
accuracy: 0.7181 - val_loss: 0.6267 - val_accuracy: 0.7598
Epoch 5/10
93/93 [=====] - 80s 865ms/step - loss: 0.6954 -
accuracy: 0.5232 - val_loss: 0.6920 - val_accuracy: 0.5202
Epoch 6/10
93/93 [=====] - 81s 871ms/step - loss: 0.6916 -
accuracy: 0.5247 - val_loss: 0.6916 - val_accuracy: 0.5202
Epoch 7/10
93/93 [=====] - 80s 860ms/step - loss: 0.6907 -
accuracy: 0.5223 - val_loss: 0.6935 - val_accuracy: 0.4798
Epoch 8/10
93/93 [=====] - 83s 898ms/step - loss: 0.6910 -
accuracy: 0.5245 - val_loss: 0.6910 - val_accuracy: 0.5202
Epoch 9/10
93/93 [=====] - 87s 939ms/step - loss: 0.6769 -
accuracy: 0.5618 - val_loss: 0.7113 - val_accuracy: 0.5202
Epoch 10/10
93/93 [=====] - 87s 941ms/step - loss: 0.5692 -
accuracy: 0.6793 - val_loss: 0.4762 - val_accuracy: 0.7544

```

Evaluation

```

[33]: # Print the accuracy of the model on the training data
print("Accuracy of the model on Training Data is - ", model.evaluate(X_train,
    ↪y_train)[1] * 100, "%")

# Print the accuracy of the model on the testing data
print("Accuracy of the model on Testing Data is - ", model.evaluate(X_test,
    ↪y_test)[1] * 100, "%")

```

```

1053/1053 [=====] - 48s 46ms/step - loss: 0.4732 -
accuracy: 0.7583
Accuracy of the model on Training Data is - 75.82632899284363 %
351/351 [=====] - 16s 45ms/step - loss: 0.4738 -
accuracy: 0.7601
Accuracy of the model on Testing Data is - 76.0089099407196 %

```

```

[34]: # Create a figure for the plot
plt.figure()

# Plot the training accuracy over epochs and label it as "Train"
plt.plot(history.history["accuracy"], label="Train")

```

```

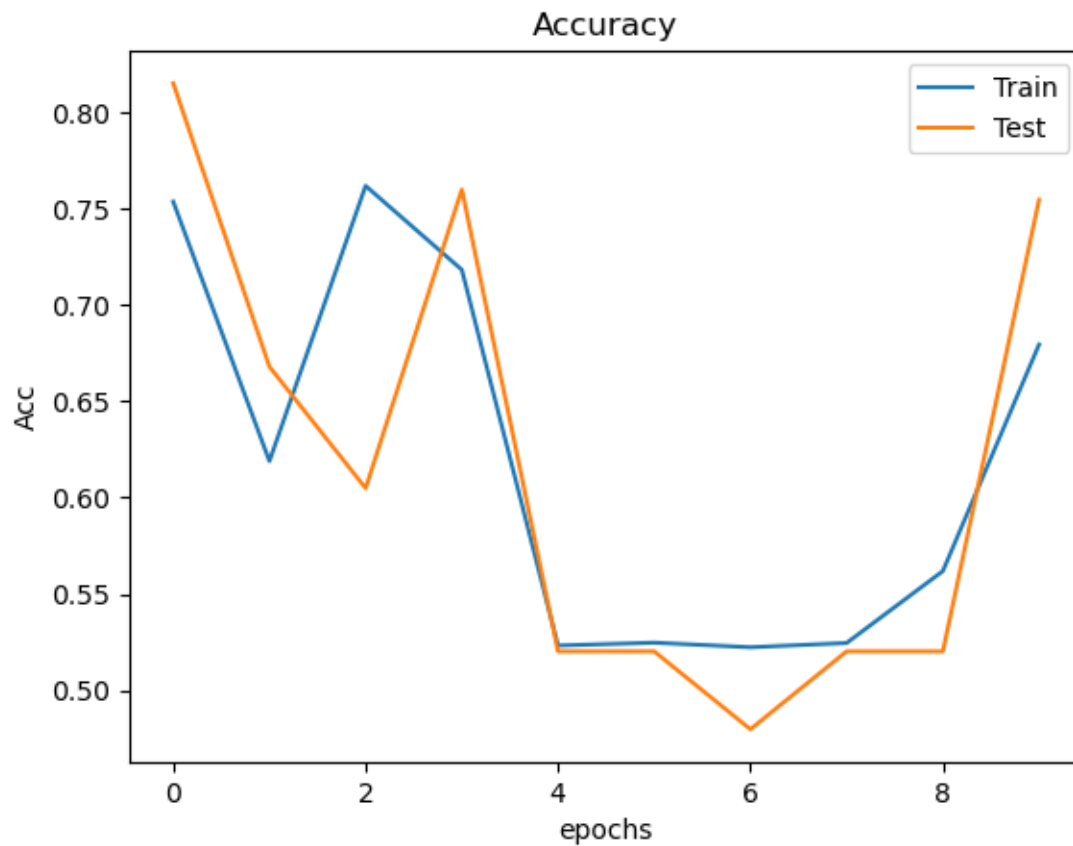
# Plot the testing accuracy over epochs and label it as "Test"
plt.plot(history.history["val_accuracy"], label="Test")

# Set the title and labels for the plot
plt.title("Accuracy")
plt.ylabel("Accuracy")
plt.xlabel("Epochs")

# Display a legend to distinguish the "Train" and "Test" lines
plt.legend()

# Show the plot
plt.show()

```



```

[35]: # Create a figure for the plot
plt.figure()

# Plot the training loss over epochs and label it as "Train"
plt.plot(history.history["loss"], label="Train")

```

```

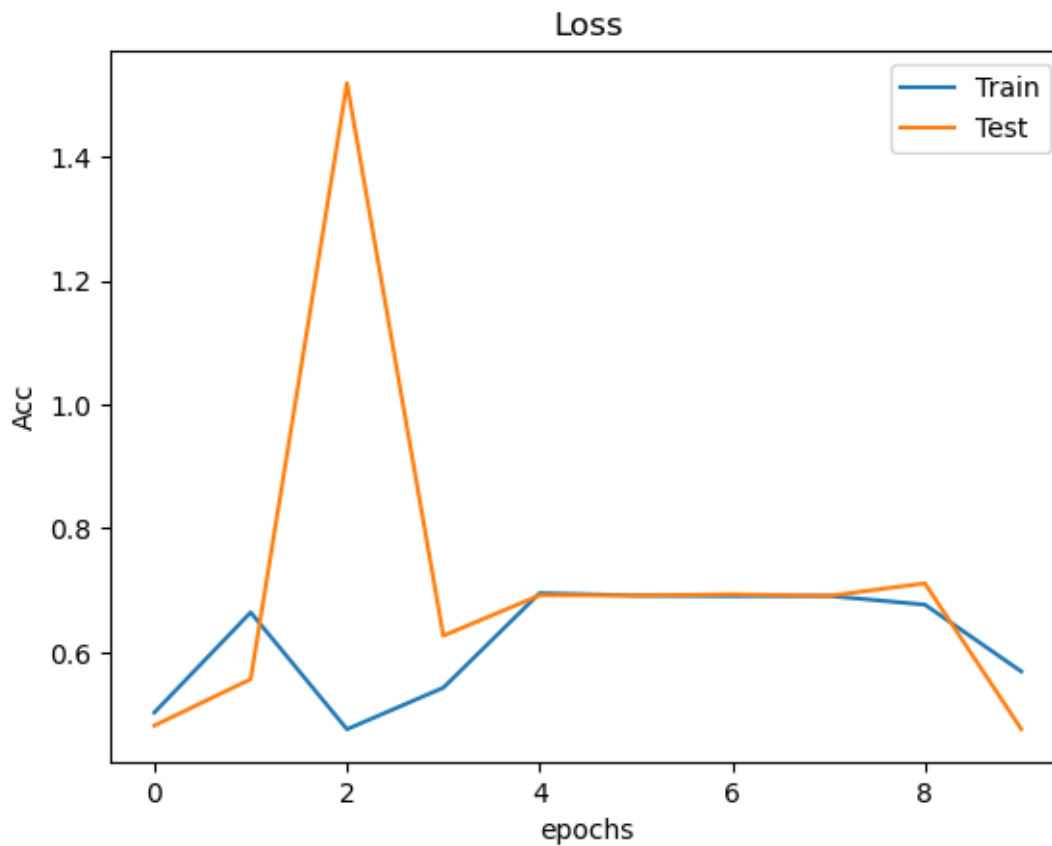
# Plot the testing loss over epochs and label it as "Test"
plt.plot(history.history["val_loss"], label="Test")

# Set the title and labels for the plot
plt.title("Loss")
plt.ylabel("Loss")
plt.xlabel("Epochs")

# Display a legend to distinguish the "Train" and "Test" lines
plt.legend()

# Show the plot
plt.show()

```



```
[50]: model.predict(X_test)
```

```
351/351 [=====] - 14s 40ms/step
```



```
[50]: array([[0.40189645],  
            [0.00880686],  
            [0.00962298],  
            ...,  
            [0.01128194],  
            [0.72117466],  
            [0.7350749 ]], dtype=float32)
```

```
[ ]:
```