Phase 2: Innovation

Introduction to Fake News Detection using NLP:

Fake news, in today's information age, presents a significant challenge to the dissemination of accurate and trustworthy information. The deliberate spread of false or misleading information through various media channels can have far-reaching consequences, from influencing public opinion to undermining trust in journalism and institutions. To combat this issue, Natural Language Processing (NLP) techniques and technologies have emerged as valuable tools in identifying and mitigating the impact of fake news.

Fake news detection using NLP involves the application of advanced computational linguistic methods to distinguish between genuine, fact-based news and fabricated, misleading content. This is achieved by analyzing the textual content, context, and linguistic patterns within news articles, social media posts, and other textual sources. The goal is to develop automated systems that can accurately classify information as either real or fake, aiding both individuals and organizations in making informed decisions and preventing the spread of misinformation.

1. Advanced Techniques and BERT Integration:

- ***In this phase, you move beyond traditional NLP techniques and embrace advanced methods, with a primary focus on integrating BERT (Bidirectional Encoder Representations from Transformers). BERT is a state-of-the-art deep learning model in NLP known for its ability to capture complex relationships in text data.***

2. Tokenization:

- ***BERT requires tokenization of input text. Tokenization is the process of breaking down a piece of text into smaller units, typically words or subwords. BERT handles variable-length sequences efficiently, and you'll need to integrate a BERT tokenizer into your project. BERT tokenization is subword-based and can capture fine-grained linguistic information.***

3. Model Architecture:

- **Designing a BERT-based model architecture is a crucial step. BERT models are known for their deep and complex architectures. BERT's architecture includes multiple layers of attention mechanisms, which allows it to understand the context of words in a sentence, including the relationships between them. Your model should be designed for binary classification, distinguishing between real and fake news.**

4. Training and Evaluation:

- **Train the BERT-based model on your preprocessed data. BERT models can be computationally intensive due to their complexity. Training will likely require substantial computational resources. After training, evaluate the model's performance using appropriate metrics like accuracy, precision, recall, F1-score, and possibly the AUC-ROC curve to assess its ability to discriminate between real and fake news.**

5. Hyperparameter Tuning:

- ◆ **Experiment with hyperparameter tuning to optimize the BERT-based model's performance. This may involve adjusting learning rates, batch sizes, and other hyperparameters specific to BERT. Fine-tuning BERT for your specific fake news detection task is essential for achieving the best results.**

6. Error Analysis:

- ◆ **Analyze the model's misclassifications to gain insights into areas where it struggles. This could involve examining the types of false positives and false negatives the model produces. Such an analysis can guide further improvements in your model or data preprocessing steps, helping you refine the model's performance.**

7. Deployment (if applicable):

- ◆ **Consider how you'll deploy the BERT-based model in a real-world application. Deployment can involve creating a web service or API that allows users to input news articles, and the model will make predictions on whether they are real or fake. Deploying deep learning models like BERT typically requires infrastructure to handle inference requests efficiently.**

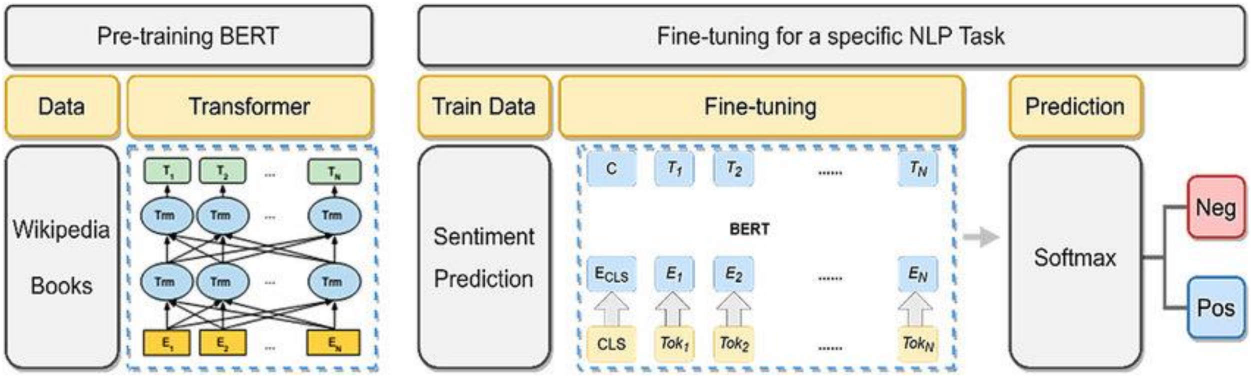
Some Advanced Techniques

BERT (Bidirectional Encoder Representations from Transformers):

BERT is a pre-trained deep learning model introduced by Google in 2018. It is designed to understand the context and semantics of words in a sentence by considering both left and right context simultaneously. This bidirectional understanding of text is a significant departure from earlier models that typically focused on either left-to-right or right-to-left language modeling.

Key features of BERT:

- ◆ ***Bidirectional Context***
- ◆ ***Transformer Architecture***
- ◆ ***Pre-training and Fine-Tuning***
- ◆ ***State-of-the-Art Results***

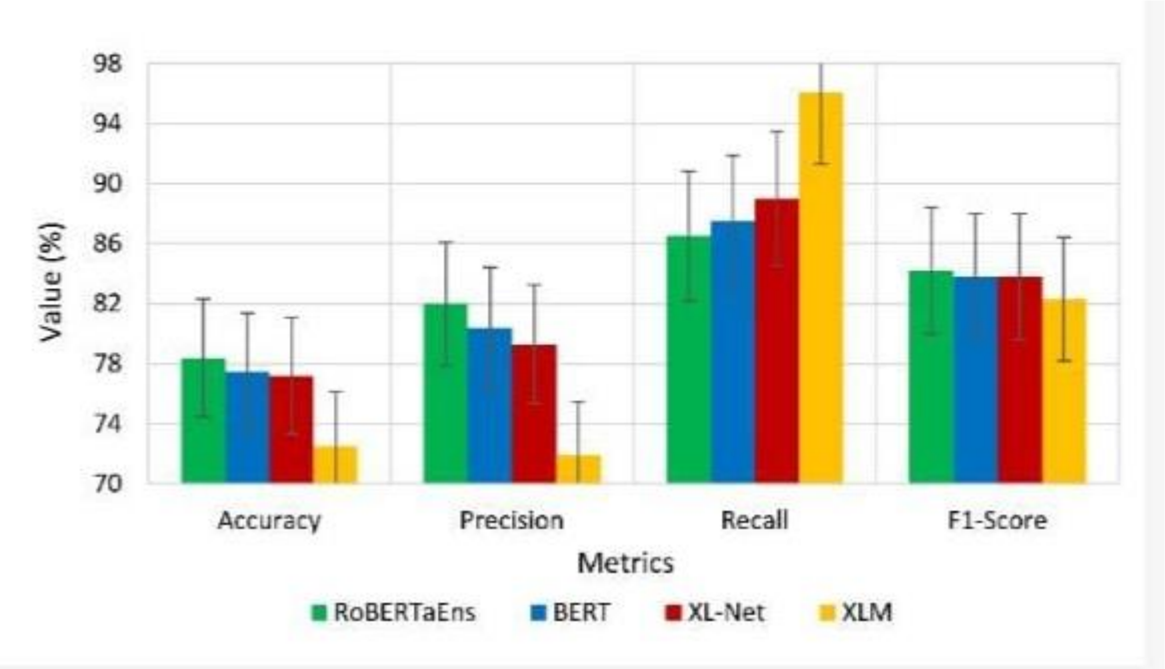


RoBERTa (A Robustly Optimized BERT Pretraining Approach):

RoBERTa, introduced by Facebook AI in 2019, can be thought of as an extension and optimization of the BERT model. It aims to improve upon BERT's performance by addressing some of its limitations.

Key features of RoBERTa:

- ***Large-Scale Training***
- ***Dynamically Masked Data***
- ***Training Variant***
- ***Improved Results***



Program :

[16]:

```
import numpy as
np import pandas
as pd
from nltk.corpus import stopwords
import plotly.express as px
from wordcloud import
WordCloud
from matplotlib import pyplot as plt
from sklearn.model_selection import train_test_split
from sklearn.feature_extraction.text import CountVectorizer
import tensorflow as tf
from tensorflow.keras.callbacks import EarlyStopping
from sklearn.metrics import accuracy_score
```

[17]:

```
fake_news = pd.read_csv('Fake.csv')
true_news = pd.read_csv('True.csv')
fake_news.head(10)
```

[17]:

```
                                               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...
5    Racist Alabama Cops Brutalize Black Boy While...
6    Fresh Off The Golf Course, Trump Lashes Out A...
7    Trump Said Some INSANELY Racist Stuff Inside ...
8    Former CIA Director Slams Trump Over UN Bully...
9    WATCH: Brand-New Pro-Trump Ad Features So Muc...

                                                 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
```

```
5  The number of cases of cops brutalizing and ki...    News
6  Donald Trump spent a good portion of his day a...    News
7  In the wake of yet another court decision that...    News
8  Many people have raised the alarm regarding th...    News
9  Just when you might have thought we d get a br...    News

                date
0  December 31, 2017
1  December 31, 2017
2  December 30, 2017
3  December 29, 2017
4  December 25, 2017
5  December 25, 2017
6  December 23, 2017
7  December 23, 2017
8  December 22, 2017
9  December 21, 2017
```

```
[18]: true_news.head(10)
```

```
[18] :                                             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...
5  White House, Congress prepare for talks on spe...
6  Trump says Russia probe will be fair, but time...
7  Factbox: Trump on Twitter (Dec 29) - Approval ...
8       Trump on Twitter (Dec 28) - Global Warming
9  Alabama official to certify Senator-elect Jone...

                                                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
5  WEST PALM BEACH, Fla./WASHINGTON (Reuters) - T...  politicsNews
6  WEST PALM BEACH, Fla (Reuters) - President Don...  politicsNews
7  The following statements were posted to the ve...  politicsNews
8  The following statements were posted to the ve...  politicsNews
9  WASHINGTON (Reuters) - Alabama Secretary of St...  politicsNews

                 date
0  December 31, 2017
1  December 29, 2017
```

```
2   December 31, 2017
3   December 30, 2017
4   December 29, 2017
5   December 29, 2017
6   December 29, 2017
7   December 29, 2017
8   December 29, 2017
9   December 28, 2017
```

[19] :
```
fake_news.info()
```

```
<class   'pandas.core.frame.DataFrame'>
RangeIndex: 23481 entries, 0 to 23480
Data columns (total 4 columns):
 #   Column    Non-Null Count   Dtype
---  -------   --------------   ------
 0   title     23481 non-null   object
 1   text      23481 non-null   object
 2   subject   23481 non-null   object
 3   date      23481 non-null   object
dtypes: object(4)
memory usage: 733.9+ KB
```

[20] :
```
true_news['True']  =  1
fake_news['True']  =  0
```

[21] :
```
true_news.drop(columns=['title','subject','date'])
```

[21]:
```
                                                    text  True
0      WASHINGTON (Reuters) - The head of a conservat...     1
1      WASHINGTON (Reuters) - Transgender people will...     1
2      WASHINGTON (Reuters) - The special counsel inv...     1
3      WASHINGTON (Reuters) - Trump campaign adviser ...     1
4      SEATTLE/WASHINGTON (Reuters) - President Donal...     1
...                                                  ...   ...
21412  BRUSSELS (Reuters) - NATO allies on Tuesday we...     1
21413  LONDON (Reuters) - LexisNexis, a provider of l...     1
21414  MINSK (Reuters) - In the shadow of disused Sov...     1
21415  MOSCOW (Reuters) - Vatican Secretary of State ...     1
21416  JAKARTA (Reuters) - Indonesia will buy 11 Sukh...     1

[21417 rows x 2 columns]
```

[22] :
```
fake_news.drop(columns=['title','subject','date'])
```

[22] :
```
                                                    text  True
0      Donald Trump just couldn t wish all Americans ...     0
```

```
1        House Intelligence Committee Chairman Devin Nu...     0
2        On Friday, it was revealed that former Milwauk...     0
3        On Christmas day, Donald Trump announced that ...     0
4        Pope Francis used his annual Christmas Day mes...     0
...                                                    ...   ...
23476    21st Century Wire says As 21WIRE reported earl...     0
23477    21st Century Wire says It s a familiar theme. ...     0
23478    Patrick Henningsen  21st Century WireRemember ...     0
23479    21st Century Wire says Al Jazeera America will...     0
23480    21st Century Wire says As 21WIRE predicted in ...     0

[23481 rows x 2 columns]
```

[23] :

```
dataset = pd.concat([true_news, fake_news], axis=0)
clean_data = dataset.drop(columns=['title','subject','date'])
clean_data
```

[23]:

```
                                                    text  True
0        WASHINGTON (Reuters) - The head of a conservat...     1
1        WASHINGTON (Reuters) - Transgender people will...     1
2        WASHINGTON (Reuters) - The special counsel inv...     1
3        WASHINGTON (Reuters) - Trump campaign adviser ...     1
4        SEATTLE/WASHINGTON (Reuters) - President Donal...     1
...                                                    ...   ...
23476    21st Century Wire says As 21WIRE reported earl...     0
23477    21st Century Wire says It s a familiar theme. ...     0
23478    Patrick Henningsen  21st Century WireRemember ...     0
23479    21st Century Wire says Al Jazeera America will...     0
23480    21st Century Wire says As 21WIRE predicted in ...     0

[44898 rows x 2 columns]
```

[24] :

```
clean_data.dtypes
```

[24] :

```
text      object
True       int64
dtype: object
```

[25] :

```
sub  =  dataset.groupby('subject').count()['title']
print(sub)
plt.figure(figsize=(10,10))
px.pie(dataset['subject'],names=dataset['subject'],title='Subject')
```

```
subject
Government News      1570
Middle-east           778
News                 9050
```

```
US_News                783
left-news             4459
politics              6841
politicsNews         11272
worldnews            10145
Name: title,  dtype: int64

<Figure size  1000x1000  with  0  Axes>
```

[26] :
```
x =
clean_data.iloc[:,0]  y
= clean_data['True']
```

```
x :
 0      WASHINGTON (Reuters) - The head of a conservat...
1      WASHINGTON  (Reuters)  -  Transgender  people  will...
2      WASHINGTON  (Reuters)  -  The  special  counsel  inv...
3      WASHINGTON  (Reuters)  -  Trump  campaign  adviser  ...
4      SEATTLE/WASHINGTON  (Reuters)  -  President  Donal...
5      WEST  PALM  BEACH,  Fla./WASHINGTON  (Reuters)  -  T...
6      WEST  PALM  BEACH,  Fla  (Reuters)  -  President  Don...
7      The  following  statements  were  posted  to  the  ve...
8      The  following  statements  were  posted  to  the  ve...
9      WASHINGTON (Reuters) - Alabama Secretary of St...
Name:  text,  dtype:  object
 y :
 0      1
1      1
2      1
3      1
4      1
5      1
6      1
7      1
8      1
9      1
Name:  True,  dtype:  int64
```

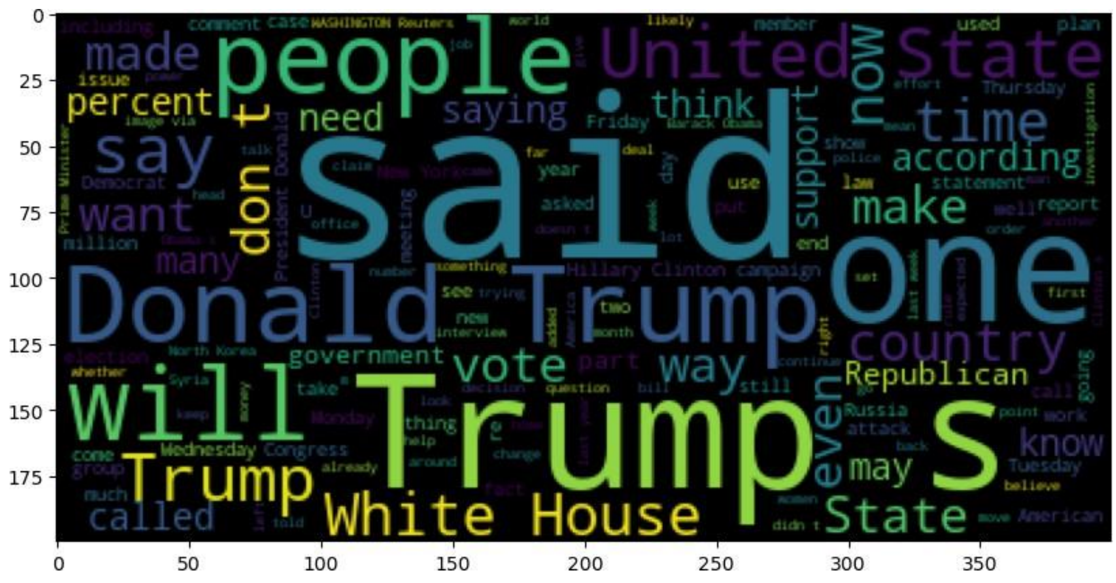
[27] :
```
para = x.tolist()
words = "
".join(para)
```

[28] :
```
wordgroup = "".join(chars)
wordgroup[0:140]
```

[28] :
```
'WASHINGTON  Reuters  The  head  of  a  conservative  Republican  faction  in  the  US
 Congress  who  voted  this  month  for  a  huge  expansion  of  the  nation'
```

[29] :
```
plt.figure(figsize=(10,10))
plt.imshow(WordCloud().generate(wordgroup))
```

[29] :
```
<matplotlib.image.AxesImage at 0x1f20cf0b070>
```



[30] :
```
print('number of words : ',len([word for word in wordgroup.split()]))
```

```
number of words :    18140003
```

[31] :
```
wordgroup.split()[0:10]
```

[31] :
```
['WASHINGTON',
 'Reuters',
 'The',
 'head',
 'of',
 'a',
 'conservative',
 'Republican',
 'faction',
 'in']
```

[32] :
```
samp =
clean_data.sample(n=3000)  samp
```

[32] :
```
                                                    text   True
9533   NEW YORK (Reuters) - Democratic Party activist...     1
2131   If you ask any conservative, Ferguson police o...     0
```

```
21708   SPOT ON RACHEL ZONATION The Obamas pride thems...       0
2144    WASHINGTON (Reuters) - A U.S. congressional pa...       1
7178    If you thought Trump supporters wered bad, wai...       0
...                                                   ...     ...
15089   ERBIL, Iraq (Reuters) - Iraqi forces launched ...       1
13085   Besides Trump, no one has a bigger target on h...       0
11346   NEW DELHI, ISLAMABAD (Reuters) - India denounc...       1
4242    SAN FRANCISCO (Reuters) - A California federal...       1
8152    (Reuters) - Members of Maná, the Spanish-langu...       1

[3000 rows x 2 columns]
```

[33] :
```
truth_dist = samp.groupby('True').count()
truth_dist
```

[33] :
```
        text
True
0       1627
1       1373
```

[34] :
```
para_samp =
samp.iloc[:,0].tolist() group ="
".join(para_samp)
chars = [char for char in group.split() if char not in string.punctuation]
print('Number of words in this 3000 entry sample data : ',len(" ".join(chars).
```

```
Number of words in this 3000 entry sample data :   1207736
```

[35] :
```
word_samp   =   "    ".join(chars).split()
words = [word.lower() for word in word_samp]
words[0:20]
```

[35] :
```
['new',
 'york',
 '(reuters)',
 'democratic',
 'party',
 'activists',
 'in',
 'some',
 'u.s.',
 'states',
 'are',
 'using',
 'donald',
 'trump,',
 'the',
 'republican',
 'presidential',
 'candidate',
 'who',
 'has']
```

[36] :
```
len(words)
```

[36]:
```
1207736
```

[37] :
```
samp.dtypes
```

[37]:
```
text      object
True       int64
dtype: object
```

[39]:
```
import nltk
```

[40]:
```
nltk.download('stopwords')
```

```
[nltk_data] Downloading package stopwords to
[nltk_data]         C:\Users\Administrator\AppData\Roaming\nltk_data...
[nltk_data]       Unzipping corpora\stopwords.zip.
```

[40]:
```
True
```

[41]:
```
import nltk
nltk.download('stopwords')

from nltk.corpus import stopwords

# Assuming you already have your 'words' list
imp_word = [word.lower() for word in words if word not in stopwords.
  □words('english')]
imp_word[0:20]
```

```
[nltk_data] Downloading package stopwords to
[nltk_data]         C:\Users\Administrator\AppData\Roaming\nltk_data...
[nltk_data]       Package stopwords is already up-to-date!
```

[41]:
```
['new',
  'york',
  '(reuters)',
  'democratic',
  'party',
  'activists',
  'u.s.',
  'states',
  'using',
  'donald',
  'trump,',
  'republican',
  'presidential',
  'candidate',
  'stirred',
  'controversy',
  'comments',
  'illegal',
  'immigrants',
  'women,']
```

[42]:

```
imp_word =[word.lower() for word in words if word not in stopwords.
  ↪words('english')]
imp_word[0:20]
```

[42]:

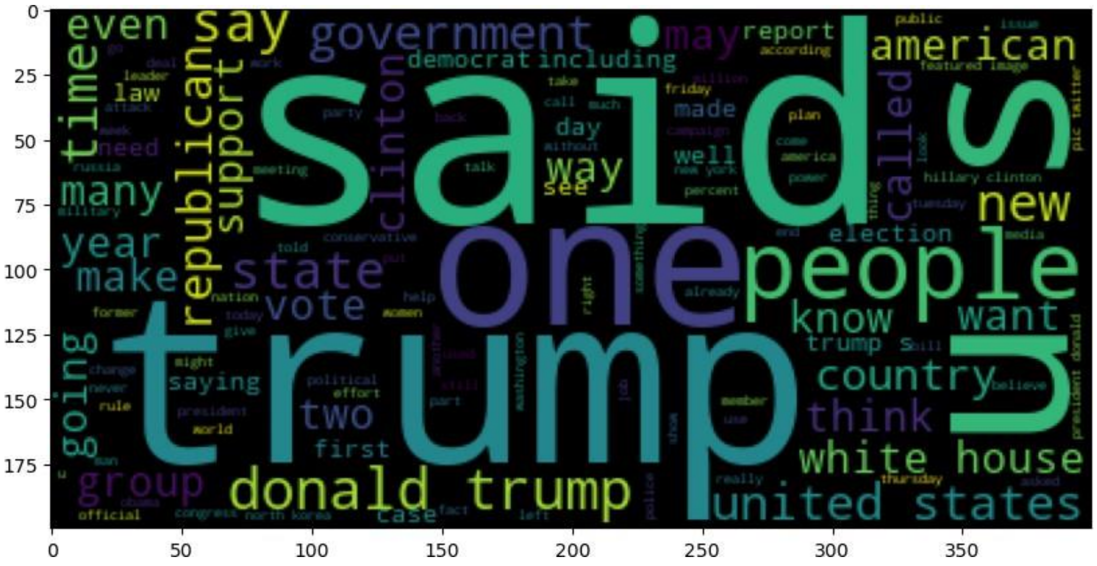
```
['new',
 'york',
 '(reuters)',
 'democratic',
 'party',
 'activists',
 'u.s.',
 'states',
 'using',
 'donald',
 'trump,',
 'republican',
 'presidential',
 'candidate',
 'stirred',
 'controversy',
 'comments',
 'illegal',
 'immigrants',
 'women,']
```

[43]:

```
plt.figure(figsize=(10,10))
plt.imshow(WordCloud().generate(" ".join(imp_word)))
```

[43] :

```
<matplotlib.image.AxesImage at 0x1f2a5efc460>
```



[44] :
```
vect =
CountVectorizer().fit_transform(para_samp).toarray() vect
```

[44]:
```
array([[0, 0, 0, ..., 0, 0, 0],
       [0, 0, 0, ..., 0, 0, 0],
       [0, 1, 0, ..., 0, 0, 0],
       ...,
       [0, 0, 0, ..., 0, 0, 0],
       [0, 0, 0, ..., 0, 0, 0],
       [0, 0, 0, ..., 0, 0, 0]], dtype=int64)
```

[45] :
```
vect_data =
pd.DataFrame(vect) vect_data
```

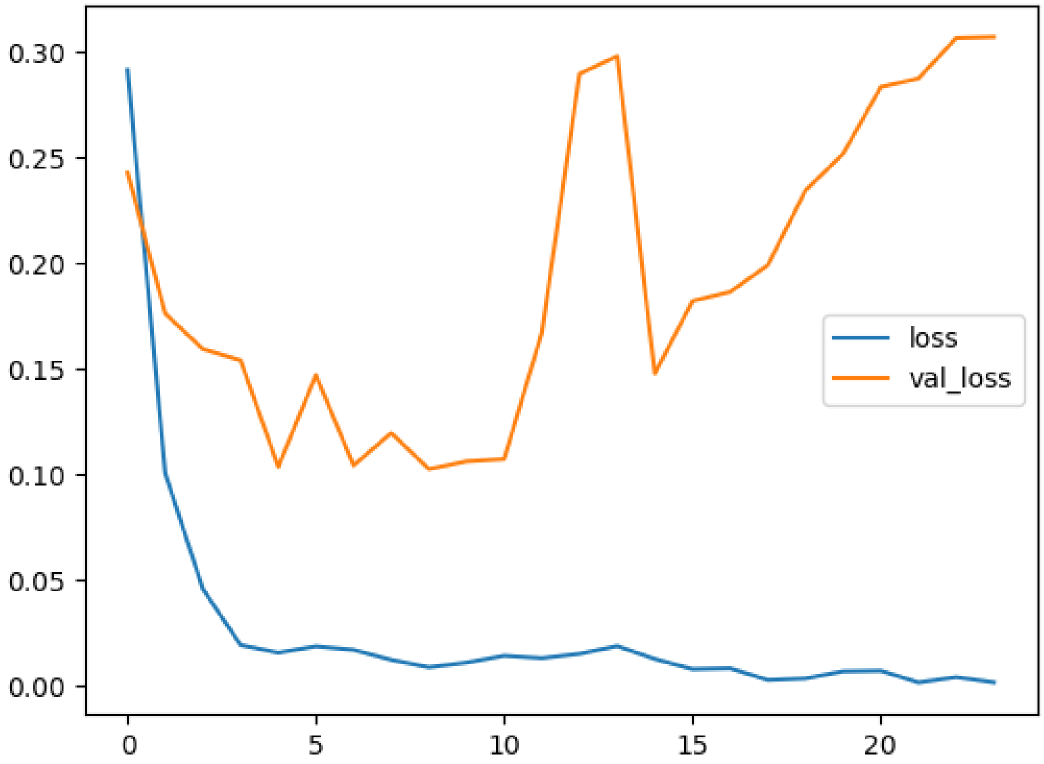
[45]:
```
        0    1    2    3    4    5    6    7    8    9    \
0       0    0    0    0    0    0    0    0    0    0
1       0    0    0    0    0    0    0    0    0    0
2       0    1    0    0    0    0    0    0    0    0
3       0    0    0    0    0    0    0    0    0    0
4       0    0    0    0    0    0    0    0    0    0
...   ...  ...  ...  ...  ...  ...  ...  ...  ...  ...
2995    0    0    0    0    0    0    0    0    0    0
2996    0    2    0    0    0    0    0    0    0    0
2997    0    0    0    0    0    0    0    0    0    0
2998    0    0    0    0    0    0    0    0    0    0
2999    0    0    0    0    0    0    0    0    0    0

      ...  37668  37669  37670  37671  37672  37673  37674  37675  37676  \
0       ...     0       0       0       0       0       0       0       0       0
1       ...     0       0       0       0       0       0       0       0       0
2       ...     0       0       0       0       0       0       0       0       0
3       ...     0       0       0       0       0       0       0       0       0
4       ...     0       0       0       0       0       0       0       0       0
...   ...   ...   ...   ...   ...   ...   ...   ...   ...   ...
2995    ...     0       0       0       0       0       0       0       0       0
2996    ...     0       0       0       0       0       0       0       0       0
2997    ...     0       0       0       0       0       0       0       0       0
2998    ...     0       0       0       0       0       0       0       0       0
2999    ...     0       0       0       0       0       0       0       0       0

        37677
0           0
1           0
2           0
3           0
4           0
...     ...
2995        0
2996        0
2997        0
2998        0
2999        0

[3000  rows  x  37678  columns]
```

[46] :
```
vect_data.dtypes
```

[46] :
```
0          int64
1          int64
2          int64
3          int64
4          int64
           ...
37673      int64
37674      int64
37675      int64
37676      int64
37677      int64
Length: 37678, dtype: object
```

[47] :
```
x1 = vect_data
y = samp['True']
x_train,x_test,y_train,y_test = train_test_split(x1,y, test_size = 0.2)
```

```
[48] : ES = tf.keras.callbacks.EarlyStopping(
           min_delta = 0.001 ,
           patience = 15 ,
           restore_best_weights = True
       )
       model = tf.keras.Sequential([
           layers.BatchNormalization(),
           layers.Dropout(0.3),
           layers.Dense(100, activation = 'relu'),
           layers.Dense(1, activation='sigmoid')
       ])
       model.compile(
           optimizer = 'adam',
           metrics = ['binary_accuracy'],
           loss = 'binary_crossentropy'
       )
       truth = model.fit(tf.cast(x_train , tf.float32),y_train,
                             validation_data =(x_test,y_test),
                             verbose = 0,
                            callbacks = [ES],
                             batch_size = 100,
                            epochs = 500)
       history_df = pd.DataFrame(truth.history)
       history_df.loc[:, ['loss', 'val_loss']].plot();
```


loss
val_loss