Midterm-report

January 8, 2023

1 I. Introduction

1.1 1. Domain-specific area

In this work, we present a text classifier for detecting fake news. Fake news, also known as misinformation, refers to false or misleading information presented as if it were real news. It has become a major issue in recent years, with the proliferation of social media platforms and the ease with which false information can be disseminated. The negative impact of fake news cannot be understated, as it can lead to harm to individuals and society as a whole.

To address this problem, we have developed a machine learning-based text classifier that can accurately identify fake news articles. The classifier is trained on a large dataset of real and fake news articles, and uses various features of the dataset as an input for its model.

We evaluate the performance of the classifier using f-accuracy, and show that it is able to achieve high accuracy in detecting fake news. We also discuss the potential applications of the classifier, including its use by news organizations to fact-check articles, and by social media platforms to combat the spread of fake news.

1.2 2. Objectives

This project aims to find a suitable way to perform text classification in news articles in order to classify if the article is or is not fake news. In order to adapt ourselves to the social media era and avoid the spread of misinformation we need to improve the ways we validate what is truth and what is not. Historically, we've seen that fake news can contribute to problems such as: 1. Damaging the reputation of people or businesses through spreading misinformaiton. 2. Advertise false propaganda in order to misguide elections and/or election results. 3. Generate confirmation bias manipulating one's perception of reality. 4. Estimulating conflicts in a situation where polarity is arising in society.

We've also seen the widespread of fake news during COVID which, according to studies, have been one of the causes of vaccine hesitancy, which has lead to unnecessary deaths all over the world.

This work consists in an automated way to fact-check news in order to tackle the problems above and many more.

1.3 3. Dataset

1.3.1 3.1. Description

In this work we will explore a dataset consisting of two CSV files containing classified fake and real news and we will use it to train our Machine Learning Model in order to be able to evaluate and classify other news. The language is english and the dataset consists of the following features: 1. title: The title of the news article. 2. text: The article itself. 3. subject: Examples of a subject could be: politics, middle-east and news. 4. date: The date that the article was published. ### 3.2. Dataset size The first CSV file called 'True.csv' holding the articles categorized as not fake news consists of 21417 articles. The second one called 'Fake.csv' consists of 23481 articles. ### 3.3. Data types All the data types are strings, except for the last column in the dataset which is a Date. ### 3.4. Source Source: 'Fake and real news - Classifying the news' taken from kaggle.

1.4 4. Evaluation methodology

For the evaluation of the model the technique being used here is accuracy, since it is a simple and quick way to give a perspective of the performance in one single number and also very easy to use with the classification algorithm we are using (logistic regression). We are using numpy to calculate that based on the results of the prediction.

2 II. Implementation

2.1 5. Preprocessing

2.1.1 5.1. Text representation

As for the text representation and lexical analysis we are using a Word2Vec model with the gensim library. The reason we decided to use this is due to the fact that it keeps information about the ordering of the words in the vector, which is going to be useful to later analyze the bigrams (words that keep appearing together) which can be informative in order to understand properties of fake news articles. ### 5.2 Pre-processing the data As for the preprocessing and text normalization step, we are using the following techniques: 1. Tokenizing Using nltk to separate each sentence into tokens. 2. Removing stopwords We are also using nltk's stopwords list for the english vocabulary in order to remove words that have no meaning (such as 'is' and 'are').

2.1.2 5.3 File type format

As per the file type format, the raw data is in two CSV files, which will then be added labels and merged in order to extract the features for the classifier.

2.2 Loading and inspect the dataset

[201]:

```
# Using pandas to load the dataset

import pandas as pd
import json

fake_df = pd.read_csv('Fake.csv')
true_df = pd.read_csv('True.csv')
```

[202]:

```
# Adding a label to the true and fake dataframes so we can use the classifier␣
  ↪next

fake_df['label'] = 'False'
```

```
true_df['label'] = 'True'

# Merging the two dataframes into one (we are going to need this in order to␣
 ↪train the model)
data = pd.concat([fake_df, true_df])
data

# Shuffling the information
data = data.sample(frac = 1)

# Since there are too much rows (44898) in this dataframe and it is too costly␣
 ↪to do operations such as iterate through it, I am going to use a subset of it
num_data = 10000
data_copy = data.head(num_data) # This is what we are going to be using from␣
 ↪now on
data_copy
```

[202]:

```
                                                   title  \
9108   CHAIRMAN OF DEMS FOR TRUMP: My Party is Suffer…
12861  NEW YORK TIMES Publishes Trump Tax Return From…
11216  Puerto Rico holding call with creditors, to tw…
15398  [RAW VIDEO] WHAT JEB BUSH JUST TOLD A HISPANIC…
10270  BREAKING NEWS: Vladimir Putin Retaliates After…
…                                                  …
18560  WHY IT’S GOOD NEWS For Conservatives That Bitt…
15317  New U.S. government rules restrict travel and …
15095  Indonesia warns of tough response after Papuan…
12800  Tillerson to meet Lebanon's Hariri in Paris on…
16969  Turkish police detain leading activist at airp…

                                                    text       subject  \
9108   We have to agree that the left is suffering fr…      politics
12861   In a lame effort to score political points fo…      politics
11216  NEW YORK (Reuters) - Puerto Rico is talking to…  politicsNews
15398  Bush spoke to a hispanic audience in central F…      politics
10270  Here s a question for the anti-Trump media: If…      politics
…                                                  …           …
18560  As a Wellesley graduate, I was shocked and dis…     left-news
15317  WASHINGTON/HAVANA (Reuters) - The U.S. governm…     worldnews
15095  JAKARTA (Reuters) - Indonesia s military said …     worldnews
12800  WASHINGTON (Reuters) - U.S. Secretary of State…     worldnews
16969  ISTANBUL (Reuters) - Turkish police have detai…     worldnews

                     date  label
9108         Dec 27, 2017  False
12861         Oct 2, 2016  False
11216   January 15, 2016    True
```

```
15398        Jul 29, 2015  False
10270        Jul 30, 2017  False
…                      …     …
18560        May 30, 2017  False
15317   November 8, 2017    True
15095  November 10, 2017    True
12800   December 8, 2017    True
16969    October 19, 2017    True

[10000 rows x 5 columns]
```

2.2.1 Exploratory data analysis

[203]:

```python
# Printing the unique subjects in the dataset
print("Subjects: ", data_copy.subject.unique())
```

```
Subjects:  ['politics' 'politicsNews' 'worldnews' 'left-news' 'US_News' 'News'
 'Government News' 'Middle-east']
```

[204]:

```python
# Printing the different columns
print("Columns:", data_copy.columns)
```

```
Columns: Index(['title', 'text', 'subject', 'date', 'label'], dtype='object')
```

2.3 Preprocessing the dataset

[205]:

```python
# Defining the preprocess method
import nltk
from gensim.models import Word2Vec
from nltk.corpus import stopwords

# Preprocess the sentences
def preprocess(sentences):
    # Tokenize the sentences: transforming the whole string into a list of␣
 ↪tokens. We need this for the Word2Vec model and for the classifier model
    sentences = [nltk.word_tokenize(sentence) for sentence in sentences]
    # Lowercase the words
    sentences = [[word.lower() for word in sentence] for sentence in sentences]
    # Removing stopwords
    stop_words = stopwords.words('english')
    sentences = [word for word in sentences if not word in stop_words]

    return sentences
```

[206]:

```python
# Here we are creating a new column in the dataframe called 'clean_text' and␣
 ↪adding the results of the preprocess method
```

```python
sentences = data_copy['text']
sentences = preprocess(sentences)

data_copy['clean_text'] = sentences;
data_copy.head(10)
```

```
/var/folders/65/v6ssklls6x5dnvkx1dq1vnjh0000gp/T/ipykernel_8404/3211253336.py:6:
SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  data_copy['clean_text'] = sentences;
```

[206]:

```
                                                  title  \
9108   CHAIRMAN OF DEMS FOR TRUMP: My Party is Suffer…
12861  NEW YORK TIMES Publishes Trump Tax Return From…
11216  Puerto Rico holding call with creditors, to tw…
15398  [RAW VIDEO] WHAT JEB BUSH JUST TOLD A HISPANIC…
10270  BREAKING NEWS: Vladimir Putin Retaliates After…
7875   Trump to Ryan: Do not waste time fighting Repu…
4265   Senator Warren aide said to be in running for …
17269  'Vanishing village' looks to Japan's LDP for s…
17745  HILARIOUS! Paul Joseph Watson DESTROYS Media F…
7439   Trump election puts Iran nuclear deal on shaky…

                                                   text       subject  \
9108   We have to agree that the left is suffering fr…      politics
12861   In a lame effort to score political points fo…      politics
11216  NEW YORK (Reuters) - Puerto Rico is talking to…  politicsNews
15398  Bush spoke to a hispanic audience in central F…      politics
10270  Here s a question for the anti-Trump media: If…      politics
7875   WASHINGTON (Reuters) - Republican presidential…  politicsNews
4265   WASHINGTON/BOSTON (Reuters) - Bharat R. Ramamu…  politicsNews
17269  NANMOKU, Japan (Reuters) - Chikara Imai, 73, i…     worldnews
17745  Paul Joseph Watson nails it again. In the vide…     left-news
7439   WASHINGTON (Reuters) - Donald Trump’s election…  politicsNews

                    date  label  \
9108        Dec 27, 2017  False
12861        Oct 2, 2016  False
11216  January 15, 2016    True
15398       Jul 29, 2015  False
10270       Jul 30, 2017  False
7875   October 10, 2016    True
4265     April 12, 2017    True
```

```
17269  October 17, 2017    True
17745        Oct 27, 2017   False
7439   November 9, 2016    True

                                              clean_text
9108   [we, have, to, agree, that, the, left, is, suf…
12861  [in, a, lame, effort, to, score, political, po…
11216  [new, york, (, reuters, ), -, puerto, rico, is…
15398  [bush, spoke, to, a, hispanic, audience, in, c…
10270  [here, s, a, question, for, the, anti-trump, m…
7875   [washington, (, reuters, ), -, republican, pre…
4265   [washington/boston, (, reuters, ), -, bharat, …
17269  [nanmoku, ,, japan, (, reuters, ), -, chikara,…
17745  [paul, joseph, watson, nails, it, again, ., in…
7439   [washington, (, reuters, ), -, donald, trump, …
```

2.4 Lexical Analysis

For the lexical analysis we used Word2vec model and gensim's Phrases library to create a vocabulary of bigrams. We started by preprocessing the articles in the fake dataframe, we then used this as an input to create the bigrams and the word2vec model.

2.4.1 Word2vec model

As for the word2vec model, by inspecting it we can see it has some interesting features: - Model length: 80658 - Model dimensions: 100 - Model number of words 80658 We tested it by calling similarity and some words of the vocabulary and the results have a high accuracy. Check example below.

2.4.2 Plotting a graph with the vocabulary of the Word3Vec model¶

After training the model we used matplotlib to plot the vocabulary of the model in a three-dimensional grid. For that we needed to use a Principal Component Analysis optimization (PCA) algorithm to speed up our model for generating a new data structure with the positional value of each word in the x, y, z position in order to fit them into the grid. We had to do it this way because the dimensions of the dataset we are working here are too high.

2.4.3 Text representation: Word2Vec

[215]:

```
# Using gensim's phrases to find bigrams
from gensim.models import Word2Vec
from gensim.models.phrases import Phrases, ENGLISH_CONNECTOR_WORDS

fake_sentences = preprocess(fake_df.text.values)

# Creating the model based on the sentences we have in the dataframe
bigrams = Phrases(fake_sentences)
word2vec_model = Word2Vec(bigrams[fake_sentences], min_count=3)
```

[216]:

```
# Now let us analyze some bigrams in the fake news articles: the bigrams will␣
 ↪be shown as a pair firstWord_secondWord
test_articles = data_copy.clean_text.values

data_copy['bigrams'] = bigrams[test_articles];
data_copy.head(10)
```

```
/var/folders/65/v6ssklls6x5dnvkx1dq1vnjh0000gp/T/ipykernel_8404/261825028.py:4:
SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  data_copy['bigrams'] = bigrams[test_articles];
```

[216]:

```
                                                   title  \
9108   CHAIRMAN OF DEMS FOR TRUMP: My Party is Suffer…
12861  NEW YORK TIMES Publishes Trump Tax Return From…
11216  Puerto Rico holding call with creditors, to tw…
15398  [RAW VIDEO] WHAT JEB BUSH JUST TOLD A HISPANIC…
10270  BREAKING NEWS: Vladimir Putin Retaliates After…
7875   Trump to Ryan: Do not waste time fighting Repu…
4265   Senator Warren aide said to be in running for …
17269  'Vanishing village' looks to Japan's LDP for s…
17745  HILARIOUS! Paul Joseph Watson DESTROYS Media F…
7439   Trump election puts Iran nuclear deal on shaky…

                                                    text       subject  \
9108   We have to agree that the left is suffering fr…      politics
12861   In a lame effort to score political points fo…      politics
11216  NEW YORK (Reuters) - Puerto Rico is talking to…  politicsNews
15398  Bush spoke to a hispanic audience in central F…      politics
10270  Here s a question for the anti-Trump media: If…      politics
7875   WASHINGTON (Reuters) - Republican presidential…  politicsNews
4265   WASHINGTON/BOSTON (Reuters) - Bharat R. Ramamu…  politicsNews
17269  NANMOKU, Japan (Reuters) - Chikara Imai, 73, i…     worldnews
17745  Paul Joseph Watson nails it again. In the vide…     left-news
7439   WASHINGTON (Reuters) - Donald Trump’s election…  politicsNews

                    date  label  \
9108        Dec 27, 2017  False
12861        Oct 2, 2016  False
11216  January 15, 2016   True
15398       Jul 29, 2015  False
10270       Jul 30, 2017  False
7875   October 10, 2016   True
```

```
4265     April 12, 2017    True
17269  October 17, 2017    True
17745      Oct 27, 2017   False
7439   November 9, 2016    True

                                              clean_text   \
9108   [we, have, to, agree, that, the, left, is, suf…
12861  [in, a, lame, effort, to, score, political, po…
11216  [new, york, (, reuters, ), -, puerto, rico, is…
15398  [bush, spoke, to, a, hispanic, audience, in, c…
10270  [here, s, a, question, for, the, anti-trump, m…
7875   [washington, (, reuters, ), -, republican, pre…
4265   [washington/boston, (, reuters, ), -, bharat, …
17269  [nanmoku, ,, japan, (, reuters, ), -, chikara,…
17745  [paul, joseph, watson, nails, it, again, ., in…
7439   [washington, (, reuters, ), -, donald, trump, …

                                                 bigrams
9108   [we, have, to, agree, that, the, left, is, suf…
12861  [in, a, lame, effort, to, score_political, poi…
11216  [new_york, (, reuters, ), -, puerto_rico, is, …
15398  [bush, spoke, to, a, hispanic, audience, in, c…
10270  [here, s, a, question, for, the, anti-trump, m…
7875   [washington, (, reuters, ), -, republican_pres…
4265   [washington/boston, (, reuters, ), -, bharat, …
17269  [nanmoku, ,, japan, (, reuters, ), -, chikara,…
17745  [paul_joseph, watson, nails_it, again, ., in, …
7439   [washington, (, reuters, ), -, donald_trump, '…
```

[209]:

```python
# Inspecting the fake lexicalmodel: I am going to get the word 'nation' in the list above and check for similarities

# Length of the model:
print("Model length: ", len(word2vec_model.wv.key_to_index))

# how many dimensions?
print("Model dimensions:", len(word2vec_model.wv['nation']))

# How many words in the model?
words = list(word2vec_model.wv.key_to_index)
print("Model number of words", len(words))

# Finding similar terms
word2vec_model.wv.most_similar('nation', topn=20)
```

```
Model length:  80658
Model dimensions: 100
Model number of words 80658
```

```
[209]: [('country', 0.8448327779769897),
        ('america', 0.7544978857040405),
        ('our_nation', 0.7383241653442383),
        ('world', 0.7174632549285889),
        ('eu', 0.669004917144775 4),
        ('our_country', 0.6643893718719482),
        ('democracy', 0.6319657564163208),
        ('europe', 0.6222034096717834),
        ('britain', 0.6145777106285095),
        ('society', 0.609611451625824),
        ('globe', 0.5923258066177368),
        ('generation', 0.5894155502319336),
        ('culture', 0.5885983109474182),
        ('middle_east', 0.5760666131973267),
        ('region', 0.567994236946106),
        ('continent', 0.5650137066841125),
        ('united_states', 0.5637699961662292),
        ('future', 0.5635557174682617),
        ('civil_war', 0.5629743933677673),
        ('west', 0.5547658205032349)]
```

2.5 Plotting a graph with the vocabulary of the Word3Vec model

```
[210]: import string
       from gensim.models import phrases, word2vec
       from sklearn.decomposition import PCA

       # We need to now find the vector representing each word, we can do this like so
       X = word2vec_model.wv[words]

       # Since our dataset dimensions are too high (45606),,we are going to be using␣
        ↪Principal Component Analysis (PCA) to speed up the model training for
       # our Data Visualization
       pca = PCA(n_components=3, random_state=11, whiten=True)
       clf = pca.fit_transform(X)

       # Creating a new dataframe with the model fit in order to visualize it␣
        ↪afterwards
       tmp = pd.DataFrame(clf, index=words, columns=['x', 'y', 'z'])

       tmp.head(10)
```

```
[210]:               x         y         z
       the   -5.321537  3.349342  2.914190
       ,     -1.578094  2.185891  3.523846
```

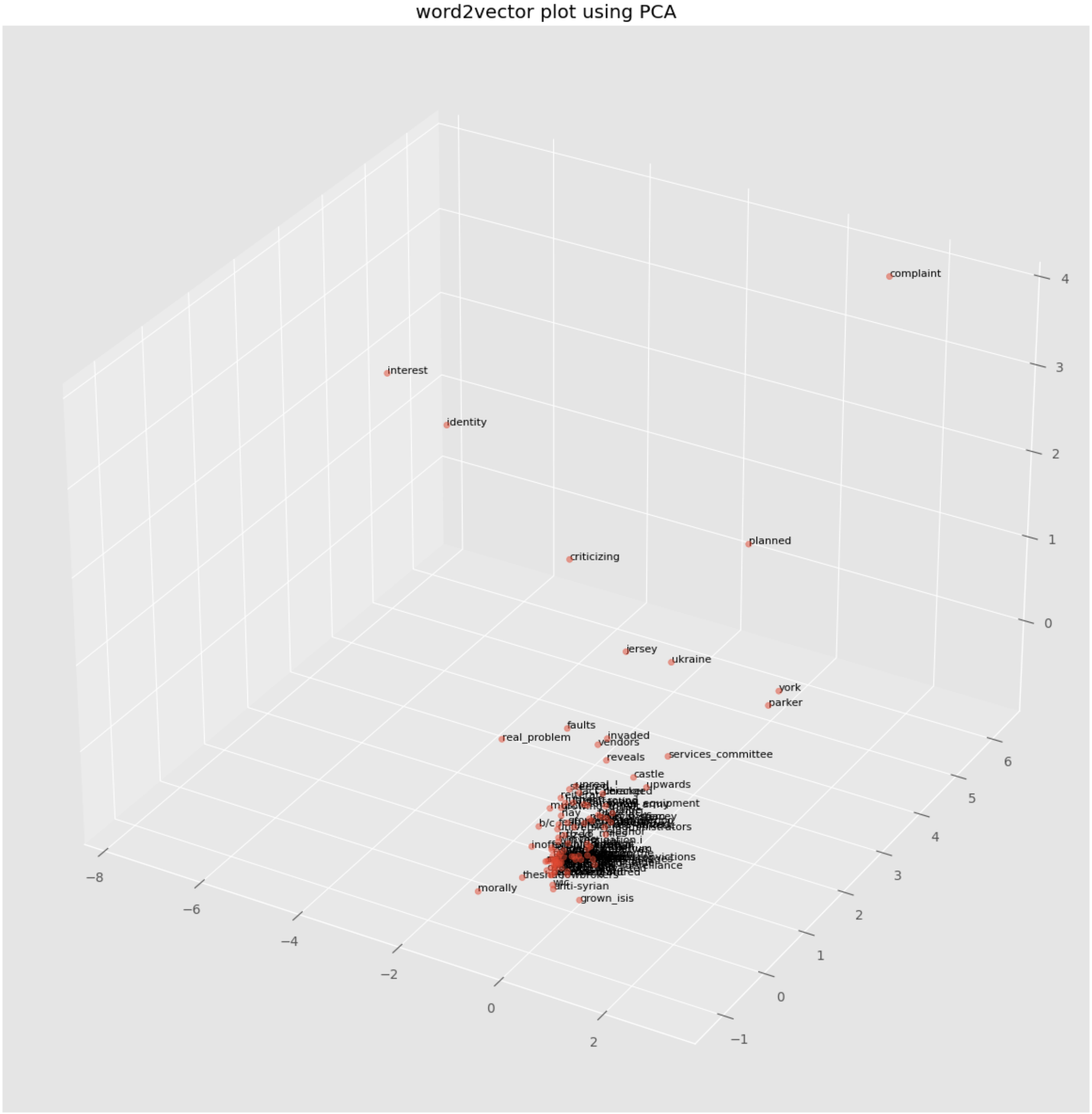
```
.    -5.440238 -0.977095  5.763877
to   -8.593275  0.498796  2.257483
of   -4.312143  2.879751  0.362549
and  -4.970900  0.787323 -0.129419
a    -3.453165  0.399685  3.711100
in   -3.603378  3.888028  1.568579
that -8.159046  0.476614  5.594429
s    -2.498318 -2.010441  4.965305
```

[221]:

```python
# Picking up a smalle sample to put in the grid
from collections import Counter

sample = tmp.sample(100)
```

[222]:

```python
import matplotlib
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D

# Ploting the sample above in a three-dimensional grid as scatter points using␣
 ↪matplotlib

matplotlib.style.use('ggplot')
%matplotlib inline

fig = plt.figure(figsize=(15, 15))
ax = fig.add_subplot(111, projection='3d')

ax.scatter(sample['x'], sample['y'], sample['z'], alpha = 0.5)

for word, row in sample.iterrows():
    x, y, z = row
    pos = (x, y, z)
    ax.text(x, y, z, s=word, size=8, zorder=1, color='k')

plt.title('word2vector plot using PCA')
plt.show()
```



2.6 6. Classification approach

2.6.1 6.1 Features and Labels

For the classifier we are using two features: the 'title' which in the dataframe is the representation of the article and the 'label' which is the feature that tells which articles are true or fake.

2.6.2 6.2 Classifier

For the classifier we are using supervised learning with a Naive Bayes algorithm due to its scalability and quickness. We started by setting the features above, then using CountVector - a feature extractor from the sklearn library - to fit the texts into the vector. Then we split the data into training and test set and created the Multinomial Naive Bayes model with the train data to train it. After training it we then tested on the test data and were able to get an accuracy of 94% with the prediction.

2.7 Creating the model for the classifier

[213]:

```
# Fake news classifier
from sklearn.model_selection import train_test_split
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.linear_model import LogisticRegression
from sklearn.naive_bayes import MultinomialNB

# Setting the features we are going to use to train our model
texts = data_copy['text'].values
labels = data_copy['label'].values

# Tokenize the texts
vectorizer = CountVectorizer()
X = vectorizer.fit_transform(texts)

# Split the data into a training set and a test set
X_train, X_test, y_train, y_test = train_test_split(X, labels, test_size=0.33,␣
  ↪random_state=42)

# Train the model
model = MultinomialNB()
model.fit(X_train, y_train)

# Test the model
y_pred = model.predict(X_test)

# Adding the prediction to the dataframe so we can inspect better the results

results = data_copy.head(3300) # This is what we are going to be using from now␣
  ↪on

results['prediction'] = y_pred;

# Let us drop the columns that we are not interested in at this point.
results.drop(columns=['clean_text', 'date'])

# Saving as CSV
results.to_csv('results.csv')

results.head(100)
```

```
/var/folders/65/v6sskl1s6x5dnvkx1dq1vnjh0000gp/T/ipykernel_8404/906315854.py:29:
SettingWithCopyWarning:
```

```
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  results['prediction'] = y_pred;
```

[213]:

```
                                                   title  \
9108   CHAIRMAN OF DEMS FOR TRUMP: My Party is Suffer…
12861  NEW YORK TIMES Publishes Trump Tax Return From…
11216  Puerto Rico holding call with creditors, to tw…
15398  [RAW VIDEO] WHAT JEB BUSH JUST TOLD A HISPANIC…
10270  BREAKING NEWS: Vladimir Putin Retaliates After…
…                                                   …
7896   Trump says Pence to represent him at Wisconsin…
2242    Ben Carson Got SMOKED By Samuel L. Jackson Fo…
17558  Kenya's Odinga says October poll would be illegal
19409  Argentina's Macri almost certain to run for re…
9850   Obama, Saudi king discuss U.S.-Saudi ties, con…

                                                    text       subject  \
9108   We have to agree that the left is suffering fr…      politics
12861   In a lame effort to score political points fo…      politics
11216  NEW YORK (Reuters) - Puerto Rico is talking to…  politicsNews
15398  Bush spoke to a hispanic audience in central F…      politics
10270  Here s a question for the anti-Trump media: If…      politics
…                                                    …           …
7896   WASHINGTON (Reuters) - U.S. Republican preside…  politicsNews
2242   For at least one day, Donald Trump did not say…          News
17558  LONDON (Reuters) - Kenya s opposition leader R…     worldnews
19409  BUENOS AIRES (Reuters) - Argentine President M…     worldnews
9850   RIYADH (Reuters) - President Barack Obama and …  politicsNews

                     date  label  \
9108         Dec 27, 2017  False
12861         Oct 2, 2016  False
11216    January 15, 2016   True
15398        Jul 29, 2015  False
10270        Jul 30, 2017  False
…                      …     …
7896      October 8, 2016   True
2242        March 7, 2017  False
17558    October 13, 2017   True
19409  September 21, 2017   True
9850       April 20, 2016   True

                                              clean_text  \
9108   [we, have, to, agree, that, the, left, is, suf…
12861  [in, a, lame, effort, to, score, political, po…
11216  [new, york, (, reuters, ), -, puerto, rico, is…
15398  [bush, spoke, to, a, hispanic, audience, in, c…
10270  [here, s, a, question, for, the, anti-trump, m…
…                                                 …
7896   [washington, (, reuters, ), -, u.s., republica…
2242   [for, at, least, one, day, ,, donald, trump, d…
17558  [london, (, reuters, ), -, kenya, s, oppositio…
19409  [buenos, aires, (, reuters, ), -, argentine, p…
9850   [riyadh, (, reuters, ), -, president, barack, …

                                                 bigrams prediction
9108   [we, have, to, agree, that, the, left, is, suf…       True
12861  [in, a, lame, effort, to, score_political, poi…       True
11216  [new_york, (, reuters, ), -, puerto_rico, is, …      False
15398  [bush, spoke, to, a, hispanic, audience, in, c…      False
10270  [here, s, a, question, for, the, anti-trump, m…      False
…                                                 …         …
7896   [washington, (, reuters, ), -, u.s., republica…      False
2242   [for, at_least, one, day, ,, donald_trump, did…      False
17558  [london, (, reuters, ), -, kenya, s, oppositio…       True
19409  [buenos_aires, (, reuters, ), -, argentine_pre…       True
9850   [riyadh, (, reuters, ), -, president_barack, o…      False

[100 rows x 8 columns]
```

3 III. Conclusions

3.1 7. Evaluation

[214]:

```
# Evaluating the accuracy of the model comparing the test and prediction data
import numpy as np

def calculate_accuracy(y_test, y_pred):
    accuracy = np.mean(y_pred == y_test)
    print(f'Accuracy: {accuracy:.2f}')

calculate_accuracy(y_test, y_pred)
```

```
Accuracy: 0.95
```

3.2 8. Summary and conclusions (finish)

3.2.1 8.1. Exploratory Data Analysis

During the exploratory data analysis phase we checked two informations about the dataset: 1. The categories (subjects) of the articles inside this dataset. The list of subjects is: ‘left-news’ ‘politics’ ‘world news’ ‘politics news’ ‘news’ ‘middle-east’, ‘US News’ ‘government news’.

2. The different columns inside the dataset and their type. All of the columns have the object type and their names is: ‘title’, ‘text’, ‘subject’, ‘date’. The fact that they are all objects made it hard for us to do any statistical analysis on top of that.

Some good ideas for extendind this project could be: 1. Checking which subjects of the above contain more fake news. 2. Checking what were that months of each year (column date) contain more fake news.

3.2.2 8.2. Lexical Analysis: Word2vec

As per the results of the lexical analysis using our Word2vec model we can see that we had a high accuracy in the results for the search of similar terms for all the words that were tested.

3.2.3 8.3. Classification Model

In terms of the classification model, even though we had a high accuracy (94%), by looking at the spreadsheet we can that the accuracy from which the model was able to classify the true news was higher than for the fake news.

```
[ ]:
```