▾ Introduction

I am identifying news items as "true" or "fake" for this project, which will be a binary classification issue - classifying the samples as positive (containing fake news) or negative (without fake news).

Attribute:

- text - text of the article; could be incomplete
- title -title of a news article
- subject - subject of the news.
- date - date of a news article

Importing dataset -downloaded dataset from kaggle

```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score
```

```
from google.colab import drive
drive.mount('/content/drive')
```

      Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.mount("/content/drive", force_remou

```
fake = pd.read_csv("/content/drive/MyDrive/ML Project/Fake.csv")
true = pd.read_csv("/content/drive/MyDrive/ML Project/True.csv")
```

```
fake.head()
```

	title	text	subject	date
0	Donald Trump Sends Out Embarrassing New Year'...	Donald Trump just couldn t wish all Americans ...	News	December 31, 2017
1	Drunk Bragging Trump Staffer Started Russian ...	House Intelligence Committee Chairman Devin Nu...	News	December 31, 2017
2	Sheriff David Clarke Becomes An Internet Joke...	On Friday, it was revealed that former Milwauk...	News	December 30, 2017
	Trump Is So Obsessed He Even Has	On Christmas day, Donald Trump		December

```
true.head()
```

	title	text	subject	date
0	As U.S. budget fight looms, Republicans flip t...	WASHINGTON (Reuters) - The head of a conservat...	politicsNews	December 31, 2017
1	U.S. military to accept transgender recruits o...	WASHINGTON (Reuters) - Transgender people will...	politicsNews	December 29, 2017
2	Senior U.S. Republican senator: 'Let Mr. Muell...	WASHINGTON (Reuters) - The special counsel inv...	politicsNews	December 31, 2017
	FBI Russia probe helped by Australian	WASHINGTON (Reuters) - Trump		December

▾ Inserting a column called "class" for fake and real news dataset to categorize fake and true news.

Creating category called "class" for fake and real news dataset to categorize fake and true news before I combined the dataset. Classified fake and true by - numerical value.

```
fake["class"] = 0
true["class"] = 1
```

Lets check the shape of the dataset

```
fake.shape, true.shape
```

```
  ((23481, 5), (21417, 5))
```

▾ Removing the Reuters

```python
# Remove the Reuters, city and twitter parts from true dataset
# Function with one accepting string statement.

def remove_news_name(iLine):
    # Split the string to list based on ") -". Because it is observed that most of the real dataset have "Reuters) - "
    line = iLine.split(') -')
    # If the above split is successful then we will have 2 items in list and we take the second block in try else we go to e
    try:
      line = line[1]
    except:
      # The news that dont contain ") -" contained ": -". So we split and remove them by next try except block.
      try:
          line = iLine.split(': -')
          line = line[1]
      except:
          # There are news with neither of both. Then we take the whole line. The frequency of such is <5%
          print(line)
          pass
    return str(line)
```

```python
# Apply keyword applies the function to each row of the pandas dataframe. This is like calling the above function for every
# We replace the filtered result in same column.
true['text'] = true['text'].apply(remove_news_name)
```

```
['WASHINGTON - Some key U.S. senators still had concerns about the Republican tax bill in the Senate, as a procedura
['The following statements\xa0were posted to the verified Twitter accounts of U.S. President Donald Trump, @realDona
["The White House on Wednesday disclosed a group of former lobbyists working in President Donald Trump's administrat
['Neil Gorsuch, President Donald Trump's appointee to the U.S. Supreme Court who was confirmed by the Senate to the
["WASHINGTON The clock began running out this week on a strategy that has provided U.S. Republicans in Congress with
['ABU DHABI - U.S. President Donald Trump's defense secretary arrived in the United Arab Emirates on Saturday for ta
["Federal appeals court judge Neil Gorsuch, the U.S. Supreme Court pick of President Donald Trump, is a conservative
['The following bullet points are from the U.S. President-Elect Donald Trump's Twitter account. Reuters has not edit
['DAVOS, Switzerland - The global economy is in better shape than it's been in years. Stock markets are booming, oil
['Republican members of Congress are complaining that U.S. intelligence agencies are refusing to brief them widely o
['Over the course of the U.S. presidential campaign, Donald Trump changed his mind on many issues. But he's been cor
['CHARLOTTE, North Carolina - Donald Trump's promise to revive small town America faces a tough challenge in an econ
['LAS VEGAS - As Republican presidential nominee Donald Trump prepared to go head-to-head with Democratic rival Hil
['After going through a week reminiscent of Napoleon's at Waterloo, Republican presidential nominee Donald Trump wil
['The following timeline charts the origin and spread of the Zika virus from its discovery nearly 70 years ago: 1947
['Global health officials are racing to better understand the Zika virus behind a major outbreak that began in Brazi
['U.S. President Barack\xa0Obama\xa0visited a street market in Luang Prabang on Wednesday (September 7), where he gr
['ALGONAC, MICH.—Parker Fox drifted out of the Donald Trump rally in a sort of euphoric daze, along with the thousar
['Global health officials are racing to better understand the Zika virus behind a major outbreak that began in Brazi
['The following timeline charts the origin and spread of the Zika virus from its discovery nearly 70 years ago: 1947
['Global health officials are racing to better understand the Zika virus behind a major outbreak that began in Brazi
['The following timeline charts the origin and spread of the Zika virus from its discovery nearly 70 years ago: 1947
['MIDDLETOWN, CONN. - Two years ago, Judy Konopka and Craig Diangelo lost their jobs in the IT department of what wa
['PITTSBURGH, Pa. - Democratic presidential candidate Hillary Clinton toured the U.S. Rust Belt on Saturday, promis
['In a speech weighted with America's complicated racial history, Democrat Hillary Clinton laced into Republican pre
['SACRAMENTO, Calif. - There is no guarantee California will vote to legalize recreational marijuana in November, bu
['WASHINGTON - Republican Donald Trump said on Thursday that if elected president Nov. 8 he would be open to drawing
[' ']
['The following timeline charts the origin and spread of the Zika virus from its discovery nearly 70 years ago: 1947
['Global health officials are racing to better understand the Zika virus behind a major outbreak that began in Brazi
['WASHINGTON - Republican presidential candidate Donald Trump said a U.S. jobs report on Friday that showed the weal
['It's the near future, and North Korea's regime is on the brink of collapse. As rumors swirl of palace coups, force
['WASHINGTON - Former U.S. Republican presidential candidate Marco Rubio on Sunday ruled out becoming Donald Trump's
['LONDON/WASHINGTON - Republican presidential candidate Donald Trump said on Friday that British Prime Minister Dav
['NEW YORK - Presumptive Republican nominee Donald Trump told Reuters in a wide-ranging interview on Tuesday that he
['WASHINGTON, 2016 - A top aide to Donald Trump said on Sunday he did not believe the Republican presidential front-
['GOP leaders have unleashed a stunning level of vitriol against their party's most successful presidential candidat
['CLEVELAND/NEW YORK - Bracing for a general election fight with Donald Trump, Democratic presidential front-runner
['Caitlyn Jenner posted a video on Wednesday (April 26) of herself using a women's bathroom at Republican President
['WASHINGTON/NEW YORK - Democratic presidential front-runner Hillary Clinton has spent about $15 per vote so far in
['WASHINGTON - Bernie Sanders won the U.S. presidential Democratic nominating contest in Wyoming on Saturday, besti
['WASHINGTON - Donald Trump proposed on Tuesday forcing Mexico to pay for his planned border wall by threatening to
['WASHINGTON - Democratic presidential front-runner Hillary Clinton rebuked Senate Republicans on Monday for denying
['WASHINGTON - Republican Ted Cruz on Friday denounced an article in the National Enquirer tabloid claiming he had a
['The Democratic and Republican nominees for the Nov. 8 presidential election are decided in a series of state-by-st
['WASHINGTON - A Donald Trump rally in Virginia was repeatedly disrupted on Monday by protesters, including some fro
['WASHINGTON - U.S. President Barack Obama on Saturday laid out a plan to help support the income of workers who los
['WASHINGTON - The chairman of a U.S. House committee that oversees child abuse issues opened an inquiry Friday into
['NEW YORK - Democrat Hillary Clinton plans to pour half of her presidential campaign's budget into advertising in t
['BALTIMORE - The prospect of running for re-election with Donald Trump at the top of the Republican ticket was worr
['WASHINGTON - President Barack Obama took aim on Tuesday at Republican presidential front-runner Donald Trump and a
['SKOPJE - Macedonia s parliament has adopted a 2018 draft budget, lowering the deficit to 2.7 percent of national o
['PYONGYANG - North Koreans stage a demonstration of devotion to their leader Kim Jong Un at least once a year, in a
['BARCELONA - Prime Minister Mariano Rajoy urged Catalans to turn out in force in a December election to  restore no
```

```
['BEIJING - China will expand a pilot project for anti-graft supervision reforms nationwide next year that will con
['DUBAI, - Billionaire Saudi Arabian Prince Alwaleed bin Talal, who owns investment firm Kingdom Holding 4280.SE, is
['MADRID - Catalan regional leader Carles Puigdemont planned on Tuesday to address a session of the regional parlia
```

```
fake.shape, true.shape
```

```
((23481, 5), (21417, 5))
```

```
fake.head()
```

	title	text	subject	date	class
0	Donald Trump Sends Out Embarrassing New Year'...	Donald Trump just couldn t wish all Americans ...	News	December 31, 2017	0
1	Drunk Bragging Trump Staffer Started Russian ...	House Intelligence Committee Chairman Devin Nu...	News	December 31, 2017	0
2	Sheriff David Clarke Becomes An Internet Joke...	On Friday, it was revealed that former Milwauk...	News	December 30, 2017	0
	Trump Is So Obsessed He Even Has Obama's	On Christmas day, Donald Trump announced		December 29,	

```
true.head()
```

	title	text	subject	date	class
0	As U.S. budget fight looms, Republicans flip t...	The head of a conservative Republican faction...	politicsNews	December 31, 2017	1
1	U.S. military to accept transgender recruits o...	Transgender people will be allowed for the fi...	politicsNews	December 29, 2017	1
2	Senior U.S. Republican senator: 'Let Mr. Muell...	The special counsel investigation of links be...	politicsNews	December 31, 2017	1
	FBI Russia probe helped by Australian	Trump campaign adviser George Papadopoulos		December 30,	

▾ Merging True and Fake Dataframes

Merged the two dataset in single dataset and save it in a csv file by using concat function in pandas.

```
# Lets combine the fake and real datasets. Concat is concatenation. So the true dataset is concatenated to fake and the new
merge = pd.concat([fake, true], axis =0 )
merge.head(10)
```

	title	text	subject	date	class
0	Donald Trump Sends Out Embarrassing New Year'...	Donald Trump just couldn t wish all Americans ...	News	December 31, 2017	0
1	Drunk Bragging Trump Staffer Started Russian ...	House Intelligence Committee Chairman Devin Nu...	News	December 31, 2017	0
2	Sheriff David Clarke Becomes An Internet Joke...	On Friday, it was revealed that former Milwauk...	News	December 30, 2017	0
3	Trump Is So Obsessed He Even Has Obama's Name...	On Christmas day, Donald Trump announced that ...	News	December 29, 2017	0
4	Pope Francis Just Called Out Donald Trump Dur...	Pope Francis used his annual Christmas Day mes...	News	December 25, 2017	0
5	Racist Alabama Cops Brutalize Black Boy While...	The number of cases of cops brutalizing and ki...	News	December 25, 2017	0
6	Fresh Off The Golf Course, Trump Lashes Out A...	Donald Trump spent a good portion of his day	News	December 23, 2017	0

```
# Check the number of rows in merged dataframe
merge.shape
```

```
(44898, 5)
```

```
merge.columns
```

```
Index(['title', 'text', 'subject', 'date', 'class'], dtype='object')
```

```
# Let's start by looking at the count of news types in our dataset.

# Our dataset has more political news than any other news followed by world news.
# We have some repeated class names which express the same meaning such as news, politics, government news, etc which is sim
```
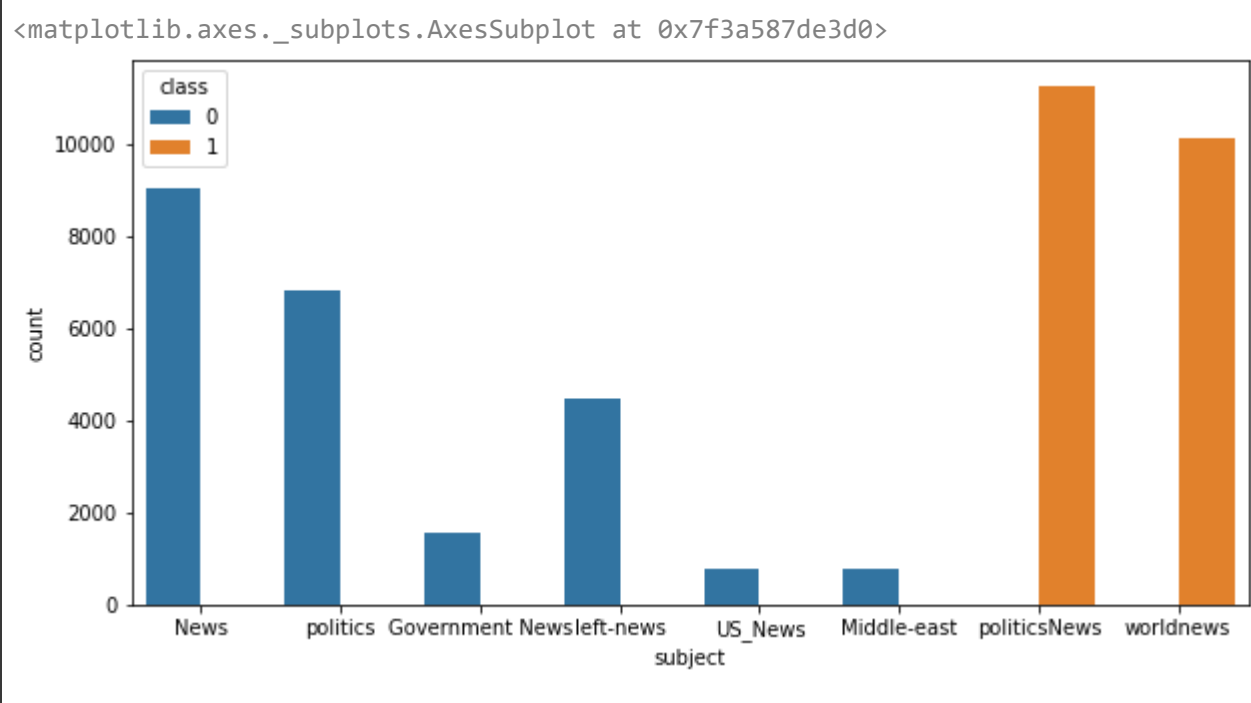
```
plt.figure(figsize=(10,5))
sns.countplot(x='subject', data=merge)
```

<matplotlib.axes._subplots.AxesSubplot at 0x7f3a5dcb1090>
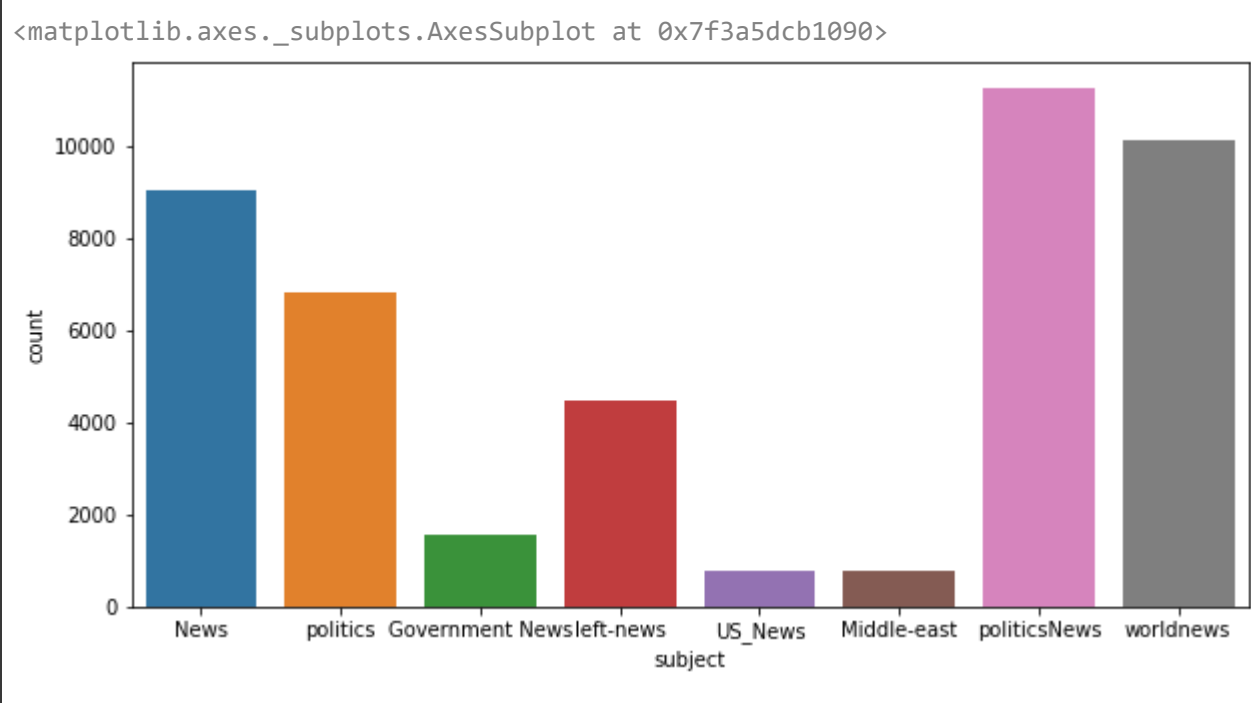

```
# Let's look at the class based on the fake/true outcome.

# from the boxplot you can see the that fake class=0 is greater than the true class=1

plt.figure(figsize=(10,5))
sns.countplot(x='subject', hue='class', data=merge)
```

<matplotlib.axes._subplots.AxesSubplot at 0x7f3a587de3d0>


```
# Verify the class balance in merged dataframe. Both classes have roughly same number of observations.

# Let's check the count of fake and true news and confirm whether our data is balanced or not.

# from the boxplot showing the fake and true news are almost balanced.

# We have a pretty much-balanced data but the count of fake news is higher than the true news but not so.

plt.figure(figsize=(10,5))
sns.countplot(x='class', data=merge)
```

<matplotlib.axes._subplots.AxesSubplot at 0x7f3a58bf3e90>
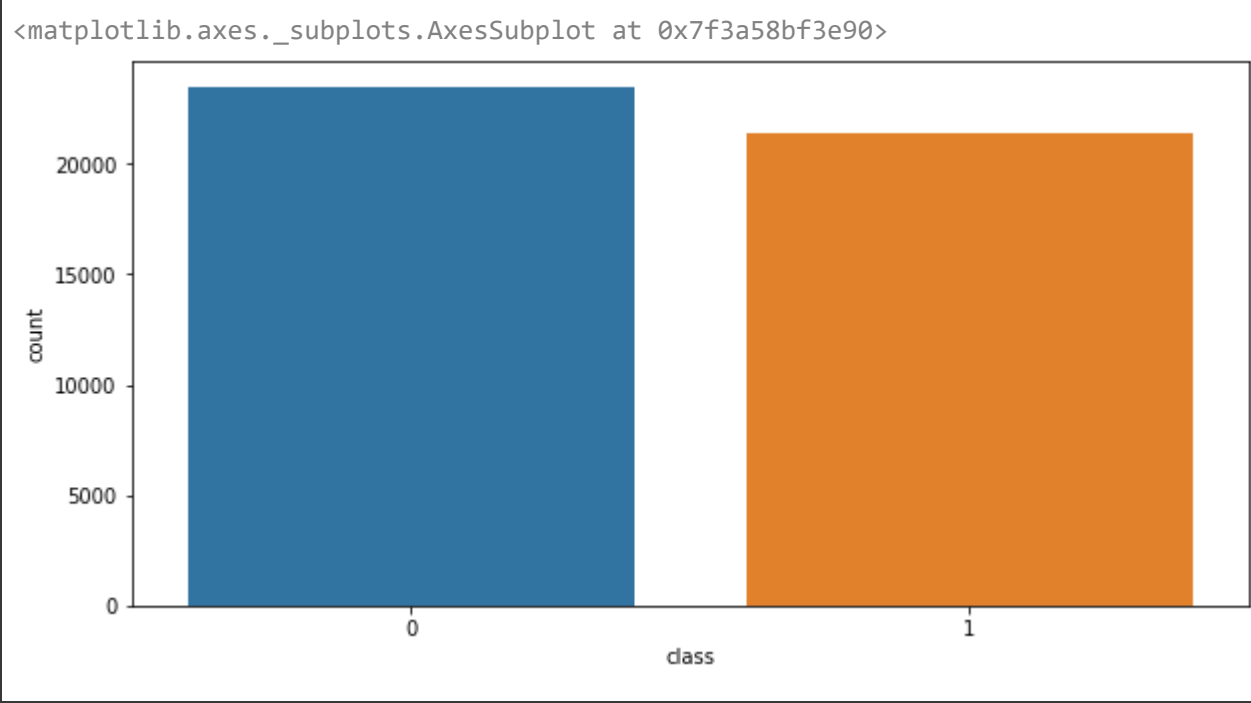
Removing columns : "subject" and "date" columns

I have dropped the subject - Because the news subject column has a non-consistent distribution in both the real and fake news datasets, so I will drop it.

dropped date - as its not important and doesnt have impact as well.

```
# We are interested in the complete text so remove the other columns.

df = merge.drop(["subject","date"], axis = 1)
```

```
df.isnull().sum()
```

```
    title    0
    text     0
    class    0
    dtype: int64
```

```
df.info()
```

```
    <class 'pandas.core.frame.DataFrame'>
    Int64Index: 44898 entries, 0 to 21416
    Data columns (total 3 columns):
     #   Column  Non-Null Count  Dtype
    ---  ------  --------------  -----
     0   title   44898 non-null  object
     1   text    44898 non-null  object
     2   class   44898 non-null  int64
    dtypes: int64(1), object(2)
    memory usage: 2.4+ MB
```

Random Shuffling the dataframe

```
# Shuffle the dataset

df = df.sample(frac = 1)
```

```
df.head(10)
```

	title	text	class
6479	Incoherent Lady Goes On CNN To Inform Paul Ry...	If there s one thing politicians should be ter...	0
5081	Speaker Ryan says Republican healthcare plan w...	U.S. House Speaker Paul Ryan said on Tuesday ...	1
2356	Tillerson says he and Trump disagree over Iran...	U.S. Secretary of State Rex Tillerson acknowl...	1
6955	This Moving Message To Trump Supporters Might...	What started as a prank to annoy Trump support...	0
10911	FURIOUS FBI Agents Speak Out On Clinton Email ...	FBI Agents are coming forward now to voice the...	0
16454	Fugitives in Kim Jong Nam killing changed clot...	Four men suspected of killing the North Korea...	1
11930	Thai junta says to allow parties to get ready ...	Thai Prime Minister Prayuth Chan-ocha said on...	1
21564	WOW! COMPANY THAT BUYS ABORTED BABY PARTS FROM...	Last we checked harvesting and selling body pa...	0
11013	A low-key Trump ends social media silence	After what seemed like a very long silence by...	1
542	GOP Implodes As Trump Launches Nasty Public F...	Donald Trump is continuing to dig himself into...	0

Resetting the index to make it easier to work with the dataframe.

```
# Since we shuffled the dataset, the index is no longer consecutive. So reset the index
df.reset_index(inplace = True)

# This creates an additional column index which is not needed. So remove the index column.
df.drop(["index"], axis = 1, inplace = True)
```

```
df.columns
```

```
    Index(['title', 'text', 'class'], dtype='object')
```

```
df.head(10)
```

	title	text	class	
0	Incoherent Lady Goes On CNN To Inform Paul Ry...	If there s one thing politicians should be ter...	0	
1	Speaker Ryan says Republican healthcare plan w...	U.S. House Speaker Paul Ryan said on Tuesday ...	1	
2	Tillerson says he and Trump disagree over Iran...	U.S. Secretary of State Rex Tillerson acknowl...	1	
3	This Moving Message To Trump Supporters Might...	What started as a prank to annoy Trump support...	0	
4	FURIOUS FBI Agents Speak Out On Clinton Email ...	FBI Agents are coming forward now to voice the...	0	
5	Fugitives in Kim Jong Nam killing changed clot...	Four men suspected of killing the North Korea...	1	
6	Thai junta says to allow parties to get ready ...	Thai Prime Minister Prayuth Chan-ocha said on...	1	
7	WOW! COMPANY THAT BUYS ABORTED BABY PARTS FROM...	Last we checked harvesting and selling body pa...	0	
8	A low-key Trump ends social media silence	After what seemed like a very long silence by...	1	
9	GOP Implodes As Trump Launches Nasty Public E...	Donald Trump is continuing to dig himself into...	0	

Defining X and Y

```
x = df["text"]
y = df["class"]
```

Splitting the dataset into training set and testing set.

Splitting data into training and testting is important part of evaluating data models. Splitting data helps confirm the creation of data models and processes that use data models. If we would not split the data into different sets the model would be evaluated on the same data it has seen during training. We could ecnounter some problems such as overfitting.

The train-test split procedure is applicable when you have a very large dataset, a valuable model to train, or require a good estimate of model performance quickly.

Train/test split: The input data is divided into two parts, that are training set and test set on a ratio of 70:30, 80:20, etc. It provides a high variance, which is one of the biggest disadvantages.

• Training Data: The training data is used to train the model, and the dependent variable is known.

• Test Data: The test data is used to make the predictions from the model that is already trained on the training data. This has the same features as training data but not the part of that.

Cross-Validation dataset: It is used to overcome the disadvantage of train/test split by splitting the dataset into groups of train/test splits, and averaging the result. It can be used if we want to optimize our model that has been trained on the training dataset for the best performance. It is more efficient as compared to train/test split as every observation is used for the training and testing both.

```
# This will split the dataframe into 75% of training and 25% of test
x_train, x_test, y_train, y_test = train_test_split(x, y, test_size=0.25)
```

Vectorization is process of mapping our natural language into numerical values which is used to make predictions using different machine learning algorithms.

Term frequency-inverse document frequency is a text vectorizer that transforms the text into a usable vector.

TF-IDF is a text vectorizer that transforms the text into a usable vector. It combines 2 concepts, Term Frequency (TF) and Document Frequency (DF).

TF is the number of occurrences of a specific term in a document. It also indicates how important a specific term in a document. TF represents every text from the data as a matrix whose rows are the number of documents and columns are the number of distinct terms throughout all documents.

```
# The feature is a bunch of words. A simple and popular way to convert words to feature is term frequency and inverse docume
# The intuition behind tfidf is that it rates a higher value to the words that are more unique towards one row. This is done
# multiplying two fractions i.e. tf and idf.
# tf is term frequency i.e. fraction of number of times word t is in the news to number of words in the news.
# idf is the fraction of log of total number of documents to the number of documents the word t is present in it.

# A sparse matrix of size (1 * number of total words) is formed for each news article.
# A sparse matrix of size (number of rows * number of total words) is formed for entire dataset.
# A sparse matrix is matrix that contains a lot of zeroes

from sklearn.feature_extraction.text import TfidfVectorizer

vectorization = TfidfVectorizer()
```

```
xv_train = vectorization.fit_transform(x_train)
xv_test = vectorization.transform(x_test)
```

Training Models

a classifier - is an algorithm that maps the input data to a specific category.

classification - refers to a predictive modeling problem where a class label is predicted for a given example of input data.

Classification - is a process of categorizing a given set of data into classes.

Classification Model – The model predicts or draws a conclusion to the input data given for training, it will predict the class or category for the data.

a class - is a discrete value from a set of predefined values

The classes - are often referred to as target, label or categories.

data set - collection of data pieces that can be treated by a computer as a single unit for analytic and prediction purposes.

Graphs are data structures that can be ingested by various algorithms

▾ Logistic Regression

Logistic regression is a simple and more efficient method for binary and linear classification problems. It is a classification model, which is very easy to realize and achieves very good performance with linearly separable classes.

```
# lets first fit a simple model with no tuning
from sklearn.linear_model import LogisticRegression
LR = LogisticRegression()

#fitting training set to the model
LR.fit(xv_train,y_train)
```

```
     LogisticRegression()
```

```
# Predicting the test set results based on the model.
predictions = LR.predict(xv_test)
```

```
LR.score = accuracy_score(y_test, predictions)
LR.score
```

```
     0.9805790645879733
```

We got a 98% accuracy. It is very high. This is due to the fact that words can be unique to each news article and the algorithms looks at those words(matrix values) and produce a result.

This can be biased because the algorithm is only good to this dataset split.

▾ Model Improvement

Lets try to improve the model a bit using GridSearch.

```
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import GridSearchCV
```

```
# Create a log space for grid search
grid={"C":np.logspace(-2,2,5), "penalty":["l2"]}
LR_Grid = LogisticRegression(max_iter=10000)

# Perform model selection using cross validation
LR_grid = GridSearchCV(LR_Grid, grid, cv=5)
LR_grid.fit(xv_train, y_train)
```

```
     GridSearchCV(cv=5, estimator=LogisticRegression(max_iter=10000),
                  param_grid={'C': array([1.e-02, 1.e-01, 1.e+00, 1.e+01, 1.e+02]),
                              'penalty': ['l2']})
```

```
# Predicting the test set results based on the model
predictions = LR_grid.predict(xv_test)
```

```
LR_grid.best_params_
```

```
    {'C': 100.0, 'penalty': 'l2'}
```

```
accuracy_score(y_test, predictions)
```

```
    0.9890423162583519
```

Decision Tree Classifier

A decision tree is just an analogy of how a human thinks to take a decision with yes/no questions.

A decision tree begins with a single point (or 'node') and then branches (or'splits') in two or more ways.

Decision trees can help to divide down complicated data into more manageable data. It is frequently used in various domains for prediction analysis, data categorization, and regression. Decision trees can deal with complex data, which is part of what makes them useful.

DT - that builds the classification model in the form of a tree structure.

The process goes on with breaking down the data into smaller structures and eventually associating it with an incremental decision tree. The final structure looks like a tree with nodes and leaves

Advantages of using DT:

- Requires minimal preparation or data cleaning before use.
- Excellent for dealing with both numerical and non-numerical data.

```
from sklearn.tree import DecisionTreeClassifier
DT = DecisionTreeClassifier()
```

```
# lets first fit a simple model with no tuning
# fitting training set to the model
DT.fit(xv_train, y_train)

# Predicting the test set results based on the model.
predictions = DT.predict(xv_test)
```

```
DT.score = accuracy_score(y_test, predictions)
DT.score
```

```
    0.949576837416481
```

I have got 94% accuracy. As you can see this is a flawed dataset and also why I can easily get such higher accuracy without any effort in processing it. Thats why I have tried to predict using the GridSearch to compare from Decision Tree method which made it the same accuracy.

The function to measure the quality of a split. Supported criteria are "gini" for the Gini impurity and "entropy" both for the Shannon information gain.

So let's go with Decision Tree with hyperparameter tuning.

Model Improvement using GridSearch

```
params = {'criterion' : ['gini', 'entropy'], 'max_depth': [1,2,3,4,5,6,7,8,9,10]}
```

```
grid = GridSearchCV(DT, params, verbose=1)
```

```
grid.fit(xv_train, y_train)
```

```
    Fitting 5 folds for each of 20 candidates, totalling 100 fits
    GridSearchCV(estimator=DecisionTreeClassifier(),
                 param_grid={'criterion': ['gini', 'entropy'],
                             'max_depth': [1, 2, 3, 4, 5, 6, 7, 8, 9, 10]},
                 verbose=1)
```

```
predictions = grid.predict(xv_test)
```

```
grid.best_params_
```

```
    {'criterion': 'entropy', 'max_depth': 10}
```

```
accuracy_score(y_test, predictions)
```

```
0.9376391982182628
```

GridSearch reached 93% a slightly improved compare to Decision Tree method.

Results

After implementing the machine learning algorithm, the accuracy of each classifier is calculated. It can be observed that DT and LR classifiers have both accuracy above 80% and the other classifier is below 80%. The results show that Logistic Regression has the most performance on this dataset in the model compare to Decision Tree.

I also think that the datasets are flawed because the results are close to 98% which is often not true in Machine Learning. That is why, I have used Gridsearch to improve the models of each classifiers. However, I still have the same results.

This can be biased because the algorithm is only good to this dataset split.

```
model_comparison = pd.DataFrame({'Model': ['Logistic Regression', 'Decision Tree'],
'Accuracy': [LR.score, DT.score]})
model_comparison
```

	Model	Accuracy
0	Logistic Regression	0.980579
1	Decision Tree	0.949577

```
plt.figure(figsize=(10,5))
sns.barplot(x = 'Accuracy', y = 'Model', data = model_comparison)
plt.title("Accuracy of Different Classifiers", fontsize = 15)
plt.xlabel('Accuracy', fontsize = 10)
```

```
Text(0.5, 0, 'Accuracy')
```


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