North East University Bangladesh (NEUB)

Department of Computer Science & Engineering

Newspaper Article Headline Category Prediction using Naïve Bayes Algorithm

Course Code: CSE-456

Course Title: Machine Learning Lab

Submitted To

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Project Title: Newspaper Article Headline Category Prediction using Naïve Bayes Algorithm.

Objectives:

Input: Headlines of Newspaper Articles.

Output: Using Naïve Bayes Algorithm, the headline will be classified into one of several categories (Sports, Religion, Science, Politics, travel, and, etc.).

Methodology:

Dataset: Newspaper articles collected from Kaggle [3].

	category	headline	authors	link	short_description	date
0	CRIME	There Were 2 Mass Shootings In Texas Last Week...	Melissa Jeltsen	https://www.huffingtonpost.com/entry/texas-ama...	She left her husband. He killed their children...	2018-05-26
1	ENTERTAINMENT	Will Smith Joins Diplo And Nicky Jam For The 2...	Andy McDonald	https://www.huffingtonpost.com/entry/will-smit...	Of course it has a song.	2018-05-26
2	ENTERTAINMENT	Hugh Grant Marries For The First Time At Age 57	Ron Dicker	https://www.huffingtonpost.com/entry/hugh-gran...	The actor and his longtime girlfriend Anna Ebe...	2018-05-26
3	ENTERTAINMENT	Jim Carrey Blasts 'Castrato' Adam Schiff And D...	Ron Dicker	https://www.huffingtonpost.com/entry/jim-carre...	The actor gives Dems an ass-kicking for not fi...	2018-05-26
4	ENTERTAINMENT	Julianna Margulies Uses Donald Trump Poop Bags...	Ron Dicker	https://www.huffingtonpost.com/entry/julianna-...	The "Dietland" actress said using the bags is ...	2018-05-26
...	...	...	...	...	...	...
200848	TECH	RIM CEO Thorsten Heins' 'Significant' Plans Fo...	Reuters, Reuters	https://www.huffingtonpost.com/entry/rim-ceo-t...	Verizon Wireless and AT&T are already promotin...	2012-01-28
200849	SPORTS	Maria Sharapova Stunned By Victoria Azarenka I...		https://www.huffingtonpost.com/entry/maria-sha...	Afterward, Azarenka, more effusive with the pr...	2012-01-28
200850	SPORTS	Giants Over Patriots, Jets Over Colts Among M...		https://www.huffingtonpost.com/entry/super-bow...	Leading up to Super Bowl XLVI, the most talked...	2012-01-28
200851	SPORTS	Aldon Smith Arrested: 49ers Linebacker Busted ...		https://www.huffingtonpost.com/entry/aldon-smi...	CORRECTION: An earlier version of this story i...	2012-01-28

Data-Preprocessing:

i) Only keep the ‘category’ and ‘headline’ columns. Drop other columns.

```
df = df.drop(columns=['authors','link','short_description','date'])
df
```

	category	headline
0	CRIME	There Were 2 Mass Shootings In Texas Last Week...
1	ENTERTAINMENT	Will Smith Joins Diplo And Nicky Jam For The 2...
2	ENTERTAINMENT	Hugh Grant Marries For The First Time At Age 57
3	ENTERTAINMENT	Jim Carrey Blasts 'Castrato' Adam Schiff And D...
4	ENTERTAINMENT	Julianna Margulies Uses Donald Trump Poop Bags...
...	...	...
200848	TECH	RIM CEO Thorsten Heins' 'Significant' Plans Fo...
200849	SPORTS	Maria Sharapova Stunned By Victoria Azarenka I...
200850	SPORTS	Giants Over Patriots, Jets Over Colts Among M...
200851	SPORTS	Aldon Smith Arrested: 49ers Linebacker Busted ...
200852	SPORTS	Dwight Howard Rips Teammates After Magic Loss ...

200853 rows × 2 columns

ii) Merge common categories, like, ‘ARTS & CULTURE’ and ‘CULTURE & ARTS’.

```
# Replace 'arts & culture' with 'culture and arts'

df['category'] = df['category'].replace('ARTS & CULTURE', 'CULTURE & ARTS')
df['category'] = df['category'].replace('PARENTING', 'PARENTS')
df['category'] = df['category'].replace('THE WORLDPOST', 'WORLDPOST')

print(df['category'])

len(df.category.unique())
```

iii) convert all the text in the ‘headline’ column to lowercase characters.

```
#convert all headlines to lowercase

df['headline'] = df['headline'].str.lower()
df
df.head(10)
```

	category	headline
0	CRIME	there were 2 mass shootings in texas last week...
1	ENTERTAINMENT	will smith joins diplo and nicky jam for the 2...
2	ENTERTAINMENT	hugh grant marries for the first time at age 57
3	ENTERTAINMENT	jim carrey blasts 'castrato' adam schiff and d...
4	ENTERTAINMENT	julianna margulies uses donald trump poop bags...
5	ENTERTAINMENT	morgan freeman 'devastated' that sexual harass...
6	ENTERTAINMENT	donald trump is lovin' new mcdonald's jingle i...
7	ENTERTAINMENT	what to watch on amazon prime that's new this ...
8	ENTERTAINMENT	mike myers reveals he'd 'like to' do a fourth ...
9	ENTERTAINMENT	what to watch on hulu that's new this week

iv) Using stop_words Library, remove common words from the **training set** like ‘the’, ‘is’, ‘at’, etc.

```
#list of common words to be removed

import re
#Remove common words from the 'train_set'

for word in stop_words:
    X_train = X_train.str.replace(r'\b' + re.escape(word) + r'\b', '', regex=True).str.strip()

X_train
```

```
7916      photos capture brutal devastation  california ...
62456     woman bitten  police dog   slept  challenging ...
27599     suicide bomb blast hits nato convoy  kabul, ki...
67362     police arrest stabbing suspect  'psycho' foreh...
139069               amazing restaurant bathrooms  america
                             ...
194442        hindu wedding planners thrive   united states
65615     ohio hospital performs first uterus transplant...
77655           story   know   women  helped overturn doma
56088         orlando attack could mark  shift  gay muslims
38408     nunes finishes rousey  ufc 207, garbrandt deth...
Name: headline, Length: 186793, dtype: object
```

iv) Using stop_words Library, remove common words from the **test set** like ‘the’, ‘is’, ‘at’, etc.

```
#remove common words from test set

for word in stop_words:
    X_test = X_test.str.replace(r'\b' + re.escape(word) + r'\b', '', regex=True).str.strip()

X_test
```

```
37896     ’ going   women’ march  washington   daughters...
28243     13 times latinos refused  stay silent  trump' ...
65110     evangelical christians hand donald trump  win ...
104989                    temporarily   physical disability
193964                                  takes  village
                                ...
143236                      ode   elasticity   mother heart
170388                                  let' talk  sex
172992    thanksgiving leftovers: 5 ways  get  diet back...
2182      beyoncé announces $100,000  scholarships  hbcu...
160756                               creating violent teens?
Name: headline, Length: 14060, dtype: object
```

v) Split data into a training set (**93%**) and test set (**7%**).

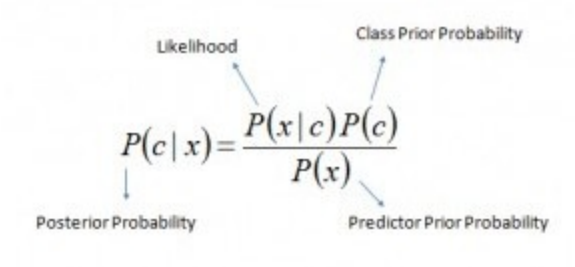
```
#splitting data into training and test set
X = df['headline']
Y = df['category']

from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, Y, random_state=100, test_size=0.07, shuffle=True)
```

```
y_test
```

```
37896            WOMEN
28243     LATINO VOICES
65110          POLITICS
104989           WOMEN
193964         WELLNESS
              ...
143236          PARENTS
170388         WELLNESS
172992     BLACK VOICES
2182          EDUCATION
160756          PARENTS
Name: category, Length: 14060, dtype: object
```

Model Training:

Using **Naïve Bayes** Algorithm, using this formula.



$$P(c \mid X) = P(x_1 \mid c) \times P(x_2 \mid c) \times \cdots \times P(x_n \mid c) \times P(c)$$

Step – 1: Find the probability of each class occurrence.

```
#finding probability of each class out of total classes

class_probability = {}

for key,value in class_count.items():
    class_probability[key] = value/total_classes

class_probability
```

```
{'POLITICS': 0.16298255287939056,
 'WELLNESS': 0.08873458855524564,
 'ENTERTAINMENT': 0.07991198813660041,
 'PARENTS': 0.06288244206153336,
 'TRAVEL': 0.049327330253275015,
 'STYLE & BEAUTY': 0.048213798161601346,
 'HEALTHY LIVING': 0.033052630451890594,
 'FOOD & DRINK': 0.031200312645548817,
 'QUEER VOICES': 0.031194959125877306,
 'WORLDPOST': 0.03113607040949072,
 'BUSINESS': 0.02955142858672434,
 'COMEDY': 0.025702247942910067,
 'SPORTS': 0.02436386802503306,
 'BLACK VOICES': 0.022522257258034296,
 'HOME & LIVING': 0.020744888727093628,
 'WEDDINGS': 0.018196613363455804,
 'WOMEN': 0.01753277692418881,
 'IMPACT': 0.017313282617656977,
 'DIVORCE': 0.017024192555395546,
 'CRIME': 0.01687429400459332,
 'MEDIA': 0.014020868019679538,
```

Step - 2: Merging all the headlines of each category separately into single strings. Each string holds all the words associated with that particular category**.**

```
#storing all the words in each class separately in a dictionary

filtered_classes = {}
new = pd.concat([y_train, X_train], axis=1)

for key,value in class_count.items():
    s = ''
    x = new.loc[df['category'] == key, 'headline']
    for item in x:
        s += item
    s = s.split()
    filtered_classes[key] = s

filtered_classes['SPORTS']
```

```
['floyd',
 'mayweather',
 "jr.'",
 'girlfriend:',
 'miss',
 'shantel',
 'jackson',
 'wears',
 'revealing',
 'dress',
 'fight',
 '(video)chloe',
 'kim',
 'said',
 "'hangry'"
```

Step - 3: Find the total number of unique words in the training dataset.

```
#finding no. of total unique words in the
total_words = []
for key, value in filtered_classes.items():
    total_words += value
```

```
len(total_words)
```

```
1081416
```

```
total_unique_words = set(total_words)
len(total_unique_words)
```

```
258210
```

Step - 4: Apply Naïve Bayes Formula to the training dataset, using the parameters calculated above

```
# Applying Naive Bayes formula to the training dataset
def findAnswer(item):
    probabilites = {}
    test_string = item
    test_list = test_string.split()

    probability_list = []

    for i in test_list:
        for key, value in filtered_classes.items():
            count = 0
            for item in value:
                if i==item:
                    count += 1
            total_class_words = len(value)
            probabilites[key] = (count+1)/(total_class_words + len(total_unique_words))
        probability_list.append(probabilites)

    answer = []
    for key, value in class_probability.items():
        a = value
        for idx, val in enumerate(test_list):
            a *= probability_list[idx][key]
        answer.append(a)

    return answer.index(max(answer))
```

Model Evaluation:

Find the accuracy using **500 test** data.

We implemented the Naïve Bayes Algorithm using full raw code, without any optimizations or library functions. There might be some mistakes in the implementation, which is why we received a low accuracy of **22.8 %**. The testing was done using only **500 test data**, due to the slowness of the algorithm and lack of proper hardware. Insha Allah, we will try to improve the algorithm to get better accuracy.

Technologies: Python, Pandas, Scikit-Learn, stop-words.

```
#finding accuracy using 500 test data

count = 0
for i in range(500):
  if x[i]==y[i]:
    count += 1

count

accuracy = (count/500)*100
accuracy
```

```
22.8
```

References:

1.

2. https://www.analyticsvidhya.com/blog/2017/09/naive-bayes-explained/

3. **Dataset** - https://www.kaggle.com/datasets/rmisra/news-category-dataset