Toxic Comment Classification using NLP

Importing libraries

```
!pip install nlp_utils
!pip install contractions
```

```
Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-wheels/public/simple/
Collecting nlp_utils
  Downloading nlp_utils-0.6.2-py2.py3-none-any.whl (112 kB)
     |████████████████████████████████| 112 kB 5.0 MB/s
Collecting micro-toolkit
  Downloading micro_toolkit-0.9.0-py2.py3-none-any.whl (9.3 kB)
Requirement already satisfied: numpy in /usr/local/lib/python3.7/dist-packages (from nlp_utils) (1.21.6)
Requirement already satisfied: nltk in /usr/local/lib/python3.7/dist-packages (from nlp_utils) (3.7)
Requirement already satisfied: joblib in /usr/local/lib/python3.7/dist-packages (from nltk->nlp_utils) (1.1.0)
Requirement already satisfied: tqdm in /usr/local/lib/python3.7/dist-packages (from nltk->nlp_utils) (4.64.0)
Requirement already satisfied: regex>=2021.8.3 in /usr/local/lib/python3.7/dist-packages (from nltk->nlp_utils) (2022.
Requirement already satisfied: click in /usr/local/lib/python3.7/dist-packages (from nltk->nlp_utils) (7.1.2)
Installing collected packages: micro-toolkit, nlp-utils
Successfully installed micro-toolkit-0.9.0 nlp-utils-0.6.2
Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-wheels/public/simple/
Collecting contractions
  Downloading contractions-0.1.72-py2.py3-none-any.whl (8.3 kB)
Collecting textsearch>=0.0.21
  Downloading textsearch-0.0.21-py2.py3-none-any.whl (7.5 kB)
Collecting pyahocorasick
  Downloading pyahocorasick-1.4.4-cp37-cp37m-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (106 kB)
     |████████████████████████████████| 106 kB 5.3 MB/s
Collecting anyascii
  Downloading anyascii-0.3.1-py3-none-any.whl (287 kB)
     |████████████████████████████████| 287 kB 42.1 MB/s
Installing collected packages: pyahocorasick, anyascii, textsearch, contractions
Successfully installed anyascii-0.3.1 contractions-0.1.72 pyahocorasick-1.4.4 textsearch-0.0.21
```

Double-click (or enter) to edit

```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
import warnings
warnings.filterwarnings('ignore')
import re
import nltk
import string
import nlp_utils
import contractions
from nltk.corpus import stopwords
from nltk.stem import WordNetLemmatizer
from nltk.tokenize import word_tokenize,sent_tokenize
from nltk.stem import PorterStemmer, LancasterStemmer, SnowballStemmer
```

Importing Dataset

```
dataset = pd.read_csv('/content/traindata.csv')
dataset
```

	id	comment_text	toxic	severe_toxic	obscene	threat	insult	identity_hate
0	0000997932d777bf	Explanation\nWhy the edits made under my usern...	0	0	0	0	0	0
1	000103f0d9cfb60f	D'aww! He matches this background colour I'm s...	0	0	0	0	0	0
2	000113f07ec002fd	Hey man, I'm really not trying to edit war. It...	0	0	0	0	0	0
3	0001b41b1c6bb37e	"\nMore\nI can't make any real suggestions on ...	0	0	0	0	0	0
4	0001d958c54c6e35	You, sir, are my hero. Any chance you remember...	0	0	0	0	0	0
...	...	...	...	...	...	...	...	...
159566	ffe987279560d7ff	":::::And for the second time of asking, when ...	0	0	0	0	0	0
159567	ffea4adeee384e90	You should be ashamed of yourself \n\nThat is ...	0	0	0	0	0	0

```
dataset.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 159571 entries, 0 to 159570
Data columns (total 8 columns):
 #   Column         Non-Null Count   Dtype 
---  ------         --------------   ----- 
 0   id             159571 non-null  object
 1   comment_text   159571 non-null  object
 2   toxic          159571 non-null  int64 
 3   severe_toxic   159571 non-null  int64 
 4   obscene        159571 non-null  int64 
 5   threat         159571 non-null  int64 
 6   insult         159571 non-null  int64 
 7   identity_hate  159571 non-null  int64 
dtypes: int64(6), object(2)
memory usage: 9.7+ MB
```

Checking the null values

```
dataset.isnull().sum()
```

```
id               0
comment_text     0
toxic            0
severe_toxic     0
obscene          0
threat           0
insult           0
identity_hate    0
dtype: int64
```

Counting threating sentence

```
dataset['toxic'].value_counts()
```

```
0    144277
1     15294
Name: toxic, dtype: int64
```

```
dataset['severe_toxic'].value_counts()
```

```
0    157976
1      1595
Name: severe_toxic, dtype: int64
```

```
dataset['obscene'].value_counts()
```

```
0    151122
1      8449
Name: obscene, dtype: int64
```

```
dataset['threat'].value_counts()
```

```
0    159093
1       478
Name: threat, dtype: int64
```

```
dataset['insult'].value_counts()
```

```
0    151694
1      7877
Name: insult, dtype: int64
```

```
dataset['identity_hate'].value_counts()
```

```
0    158166
1      1405
Name: identity_hate, dtype: int64
```

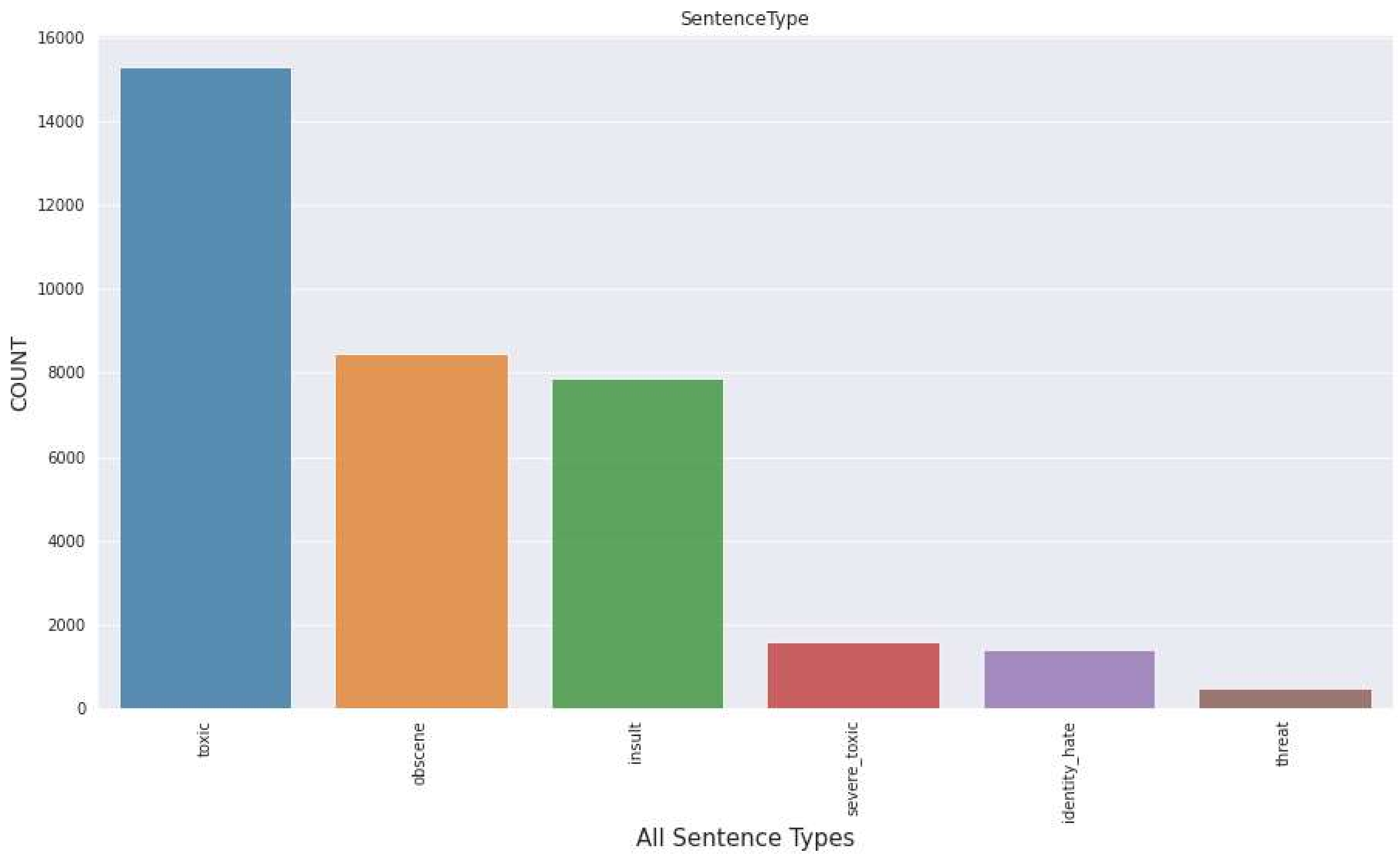
Data Visualization

```
#taking only numerical columns
num_col = dataset.iloc[:,2:].sum()
num_col
```

```
toxic            15294
severe_toxic      1595
obscene           8449
threat             478
insult            7877
identity_hate     1405
dtype: int64
```

```
sns.set_style("darkgrid")
nc = num_col.sort_values(ascending=False)
plt.figure(figsize=(15,8))
temp =sns.barplot(nc.index, nc.values, alpha=0.8)
```

```
    plt.title('SentenceType')
    plt.ylabel('COUNT', fontsize=14)
    plt.xlabel('All Sentence Types', fontsize=15)
    temp.set_xticklabels(rotation=90,labels=nc.index,fontsize=10)
    plt.show()
```



Pre-processing the data

Removing spacial characters from comments

```
import re
import string
alphanumeric = lambda x: re.sub('\w*\d\w*', ' ', x)
punc_lower = lambda x: re.sub('[%s]' % re.escape(string.punctuation), ' ', x.lower())
remove_n = lambda x: re.sub("\n", " ", x)
remove_non_ascii = lambda x: re.sub(r'[^\x00-\x7f]',r' ', x)
dataset['comment_text'] = dataset['comment_text'].map(alphanumeric).map(punc_lower).map(remove_n).map(remove_non_ascii)
```

Creating different dataframe

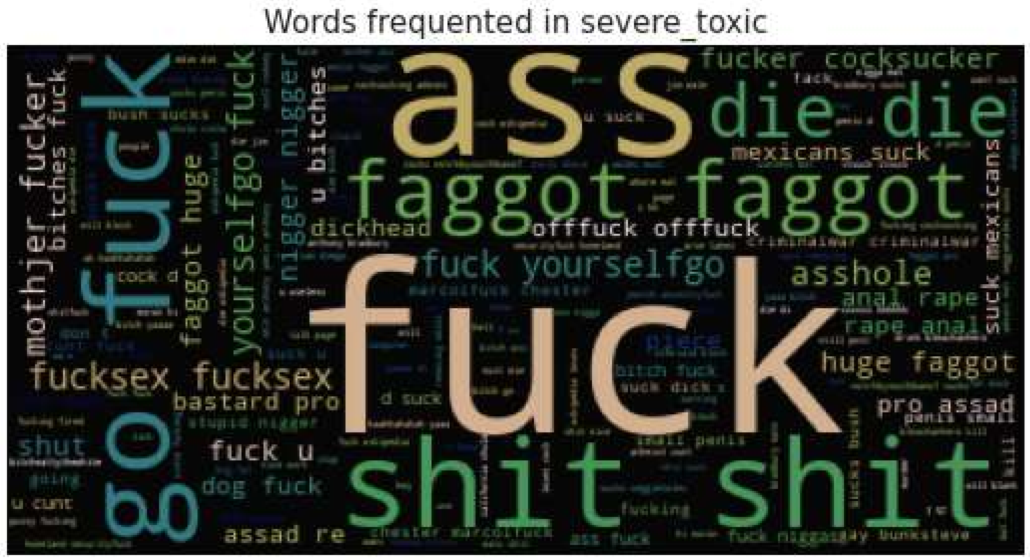
```
insulting_comment = dataset.loc[:,['id','comment_text','insult']]
hate_comment = dataset.loc[:,['id','comment_text','identity_hate']]
threatening_comment = dataset.loc[:,['id','comment_text','threat']]
obscene_comment = dataset.loc[:,['id','comment_text','obscene']]
severe_toxic_comment = dataset.loc[:,['id','comment_text','severe_toxic']]
toxic_comment = dataset.loc[:,['id','comment_text','toxic']]
```

Visualizing subset datasets using wordcloud

```
import wordcloud
from PIL import Image
from wordcloud import WordCloud, STOPWORDS, ImageColorGenerator
from nltk.corpus import stopwords
def wordcloud(dataset, label):

    subset=dataset[dataset[label]==1]
    text=subset.comment_text.values
    wc= WordCloud(background_color="black",max_words=2000)
    wc.generate(" ".join(text))
    plt.figure(figsize=(20,20))
    plt.subplot(221)
    plt.axis("off")
    plt.title("Words frequented in {}".format(label), fontsize=15)
    plt.imshow(wc.recolor(colormap= 'gist_earth' , random_state=0), alpha=0.98)
```

```
wordcloud(severe_toxic_comment,'severe_toxic')
```

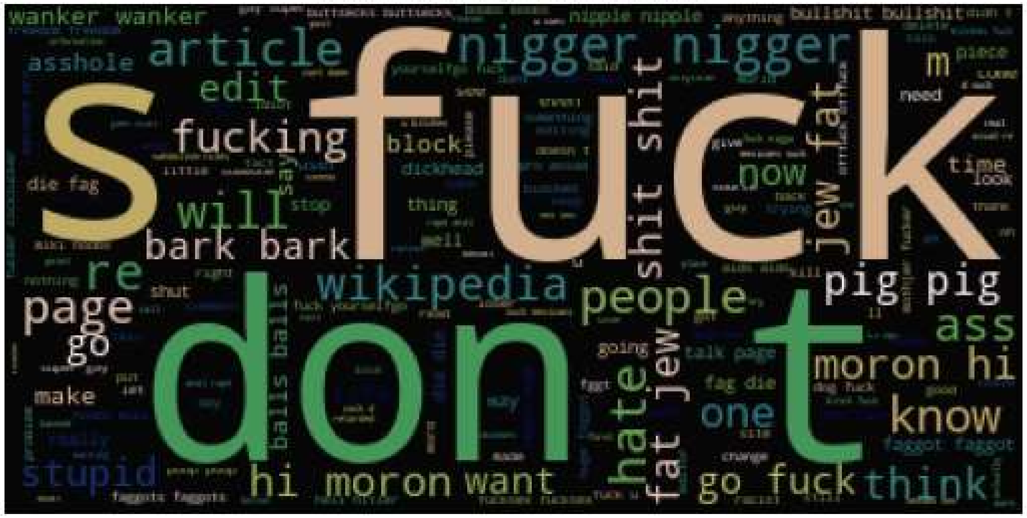


```
wordcloud(obscene_comment,'obscene')
```

Words frequented in obscene

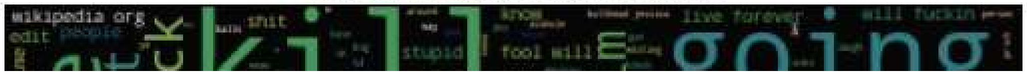
```
wordcloud(toxic_comment,'toxic')
```

Words frequented in toxic



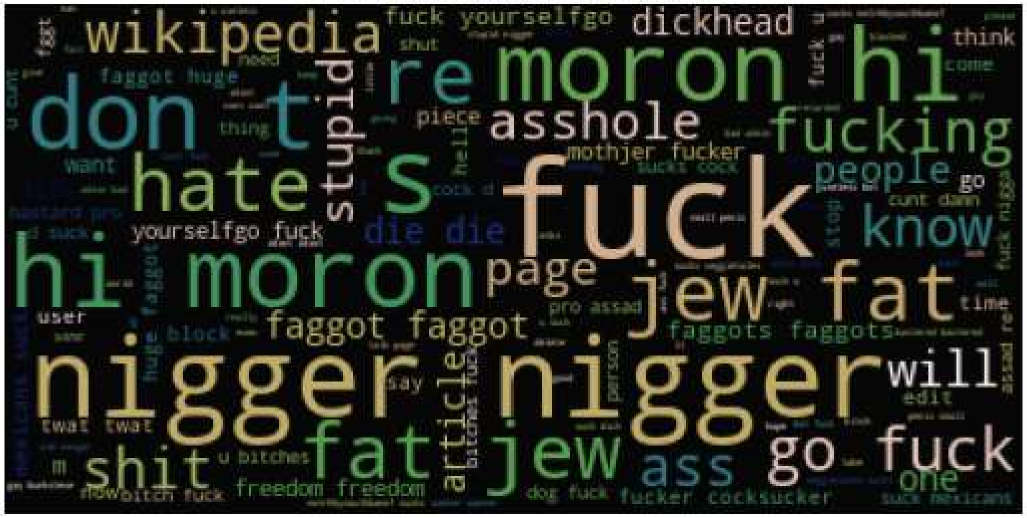
```
wordcloud(threatening_comment,'threat')
```

Words frequented in threat



```
wordcloud(insulting_comment,'insult')
```

Words frequented in insult



```
wordcloud(hate_comment,'identity_hate')
```

Balancing the target column in the dataset

```
toxic_comment['toxic'].value_counts()

     0    144277
     1     15294
     Name: toxic, dtype: int64
```

```
balanced_toxic_comment_1 = toxic_comment[toxic_comment['toxic'] == 1].iloc[0:15294,:]
balanced_toxic_comment_0 = toxic_comment[toxic_comment['toxic'] == 0].iloc[0:15294,:]
balanced_toxic_comment = pd.concat([balanced_toxic_comment_1, balanced_toxic_comment_0])
balanced_toxic_comment['toxic'].value_counts()

     1    15294
     0    15294
     Name: toxic, dtype: int64
```

```
severe_toxic_comment['severe_toxic'].value_counts()

     0    157976
     1      1595
     Name: severe_toxic, dtype: int64
```

```
balanced_severe_toxic_comment_1 = severe_toxic_comment[severe_toxic_comment['severe_toxic'] == 1].iloc[0:1595,:]
balanced_severe_toxic_comment_0 = severe_toxic_comment[severe_toxic_comment['severe_toxic'] == 0].iloc[0:1595,:]
balanced_severe_toxic_comment = pd.concat([balanced_severe_toxic_comment_1, balanced_severe_toxic_comment_0])
balanced_severe_toxic_comment['severe_toxic'].value_counts()

     1    1595
     0    1595
     Name: severe_toxic, dtype: int64
```

```
obscene_comment['obscene'].value_counts()
```

```
0    151122
1      8449
Name: obscene, dtype: int64
```

```
balanced_obscene_comment_1 = obscene_comment[obscene_comment['obscene'] == 1].iloc[0:8449,:]
balanced_obscene_comment_0 = obscene_comment[obscene_comment['obscene'] == 0].iloc[0:8449,:]
balanced_obscene_comment = pd.concat([balanced_obscene_comment_1,balanced_obscene_comment_0])
balanced_obscene_comment['obscene'].value_counts()
```

```
1    8449
0    8449
Name: obscene, dtype: int64
```

```
threatening_comment['threat'].value_counts()
```

```
0    159093
1       478
Name: threat, dtype: int64
```

```
balanced_threatening_comment_1 = threatening_comment[threatening_comment['threat'] == 1].iloc[0:478,:]
balanced_threatening_comment_0 = threatening_comment[threatening_comment['threat'] == 0].iloc[0:478,:]
balanced_threatening_comment = pd.concat([balanced_threatening_comment_1,balanced_threatening_comment_0])
balanced_threatening_comment['threat'].value_counts()
```

```
1    478
0    478
Name: threat, dtype: int64
```

```
insulting_comment['insult'].value_counts()
```

```
0    151694
1      7877
Name: insult, dtype: int64
```

```
balanced_insulting_comment_1 = insulting_comment[insulting_comment['insult'] == 1].iloc[0:7877,:]
```

```
balanced_insulting_comment_0 = insulting_comment[insulting_comment['insult'] == 0].iloc[0:7877,:]
balanced_insulting_comment = pd.concat([balanced_insulting_comment_1,balanced_insulting_comment_0])
balanced_insulting_comment['insult'].value_counts()
```

```
1    7877
0    7877
Name: insult, dtype: int64
```

```
hate_comment['identity_hate'].value_counts()
```

```
0    158166
1      1405
Name: identity_hate, dtype: int64
```

```
balanced_hate_comment_1 = hate_comment[hate_comment['identity_hate'] == 1].iloc[0:1405,:]
balanced_hate_comment_0 = hate_comment[hate_comment['identity_hate'] == 0].iloc[0:1405,:]
balanced_hate_comment = pd.concat([balanced_hate_comment_1, balanced_hate_comment_0])
balanced_hate_comment['identity_hate'].value_counts()
```

```
1    1405
0    1405
Name: identity_hate, dtype: int64
```

Machine learning

```
from sklearn import preprocessing
from sklearn.feature_selection import SelectFromModel

from sklearn.model_selection import train_test_split, KFold, cross_val_score
from sklearn.metrics import f1_score, precision_score, recall_score, precision_recall_curve, fbeta_score, confusion_matrix
from sklearn.metrics import roc_auc_score, roc_curve

from sklearn.linear_model import LogisticRegression
from sklearn.neighbors import KNeighborsClassifier
from sklearn.naive_bayes import MultinomialNB, BernoulliNB
from sklearn.svm import LinearSVC
from sklearn.ensemble import RandomForestClassifier

from sklearn.feature_extraction.text import CountVectorizer, TfidfVectorizer
from nltk import ngrams,bigrams,trigrams
```

Splitting the dataset and apply different regression model

```
def cv_tf_train_test(dataframe,label,vectorizer,ngram):

    # Split the data into X and y data sets
    X = dataframe.comment_text
    y = dataframe[label]

    # Split our data into training and test data
    X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=50)

    # Using vectorizer and removing stopwords
    cv1 = vectorizer(ngram_range=(ngram), stop_words='english')

    # Transforming x-train and x-test
    X_train_cv1 = cv1.fit_transform(X_train)
    X_test_cv1  = cv1.transform(X_test)

    ## Machine learning models

    ## Logistic regression
    lr = LogisticRegression()
    lr.fit(X_train_cv1, y_train)

    ## k-nearest neighbours
    knn = KNeighborsClassifier(n_neighbors=5)
    knn.fit(X_train_cv1, y_train)

    ## Naive Bayes
    bnb = BernoulliNB()
    bnb.fit(X_train_cv1, y_train)

    ## Multinomial naive bayes
    mnb = MultinomialNB()
    mnb.fit(X_train_cv1, y_train)
     ## Support vector machine
    svm_model = LinearSVC()
    svm_model.fit(X_train_cv1, y_train)

    ## Random Forest
    randomforest = RandomForestClassifier(n_estimators=100, random_state=50)
    randomforest.fit(X_train_cv1, y_train)

    f1_score_data = {'F1 Score':[f1_score(lr.predict(X_test_cv1), y_test), f1_score(knn.predict(X_test_cv1), y_test),
                                f1_score(bnb.predict(X_test_cv1), y_test), f1_score(mnb.predict(X_test_cv1), y_test),
                                f1_score(svm_model.predict(X_test_cv1), y_test), f1_score(randomforest.predict(X_test_cv1),
    ## Saving f1 score results into a dataframe
    dataset_f1 = pd.DataFrame(f1_score_data, index=['Log Regression','KNN', 'BernoulliNB', 'MultinomialNB', 'SVM', 'Random F

    return dataset_f1
```

Evaluating model performance

```
severe_toxic_comment_cv = cv_tf_train_test(balanced_severe_toxic_comment, 'severe_toxic', TfidfVectorizer, (1,1))
severe_toxic_comment_cv.rename(columns={'F1 Score': 'F1 Score(severe_toxic)'}, inplace=True)
severe_toxic_comment_cv
```

	F1 Score(severe_toxic)
Log Regression	0.940282

```
obscene_comment_cv = cv_tf_train_test(balanced_obscene_comment, 'obscene', TfidfVectorizer, (1,1))
obscene_comment_cv.rename(columns={'F1 Score': 'F1 Score(obscene)'}, inplace=True)
obscene_comment_cv
```

	F1 Score(obscene)
Log Regression	0.916735
KNN	0.258935
BernoulliNB	0.785481
MultinomialNB	0.897783
SVM	0.930288
Random Forest	0.910396

```
threat_comment_cv = cv_tf_train_test(balanced_threatening_comment, 'threat', TfidfVectorizer, (1,1))
threat_comment_cv.rename(columns={'F1 Score': 'F1 Score(threat)'}, inplace=True)
threat_comment_cv
```

	F1 Score(threat)
Log Regression	0.897338
KNN	0.852459
BernoulliNB	0.745205
MultinomialNB	0.902098
SVM	0.894737
Random Forest	0.923077

```
insult_comment_cv = cv_tf_train_test(balanced_insulting_comment, 'insult', TfidfVectorizer, (1,1))
insult_comment_cv.rename(columns={'F1 Score': 'F1 Score(insult)'}, inplace=True)
insult_comment_cv
```

	F1 Score(insult)
Log Regression	0.905800
KNN	0.322314
BernoulliNB	0.790283
MultinomialNB	0.902316
SVM	0.913322
Random Forest	0.894402

```
identity_hatecomment_cv = cv_tf_train_test(balanced_hate_comment, 'identity_hate', TfidfVectorizer, (1,1))
identity_hatecomment_cv.rename(columns={'F1 Score': 'F1 Score(identity_hate)'}, inplace=True)
identity_hatecomment_cv
```

	F1 Score(identity_hate)
Log Regression	0.905707
KNN	0.820046
BernoulliNB	0.776699
MultinomialNB	0.903302
SVM	0.896806
Random Forest	0.888087

Testing the model to check if the given text is toxic or not.

```
X = balanced_toxic_comment.comment_text
y = balanced_toxic_comment['toxic']

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=42)

# Initiate a Tfidf vectorizer
tfv = TfidfVectorizer(ngram_range=(1,1), stop_words='english')

X_train_fit = tfv.fit_transform(X_train)
X_test_fit = tfv.transform(X_test)
randomforest = RandomForestClassifier(n_estimators=100, random_state=50)

randomforest.fit(X_train_fit, y_train)
randomforest.predict(X_test_fit)
```

```
     array([0, 0, 0, ..., 1, 0, 0])
```

```
comment1 = ['i ate an insect']
comment1_vect = tfv.transform(comment1)
randomforest.predict_proba(comment1_vect)[:,1]
```

```
     array([0.46066312])
```

```
comment2 = ['Is this sentence a good one']
comment2_vect = tfv.transform(comment2)
randomforest.predict_proba(comment2_vect)[:,1]
```

```
     array([0.05181818])
```

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