Naive-Bayes model using text data vectorized with word2vec

In [ ]:

```
#import packages

import numpy as np

import pandas as pd

from sklearn.model_selection import KFold, cross_validate

from sklearn.pipeline import Pipeline

from sklearn.linear_model import LogisticRegression
from sklearn.naive_bayes import MultinomialNB, GaussianNB
from sklearn.svm import SVC

from sklearn.preprocessing import MinMaxScaler

from sklearn.metrics import accuracy_score, precision_score, recall_score, f1_score, confusion_matrix, ConfusionMatrixDispl

import matplotlib as plt

from time import process_time
```

In [ ]:

```
#import data

%store -r x_text_train_wv_2d
%store -r x_text_test_wv_2d
%store -r y_text_train_wv
%store -r y_text_test_wv
```

In [ ]:

```
#rename variables for ease of use

x_train =  x_text_train_wv_2d
x_test =  x_text_test_wv_2d
y_train = y_text_train_wv
y_test = y_text_test_wv
```

Multinomial Naive Bayes

In [ ]:

```
#scale data with to make usable for Multinomial NB

scaler = MinMaxScaler()

x_train_scaled = scaler.fit_transform(x_train)

x_test_scaled = scaler.fit_transform(x_test)
```

In [ ]:

```
#define model

mnb = MultinomialNB()
```

In [ ]:

```
#define scoring metrics for cross validation

scorer = {'accuracy': make_scorer(accuracy_score),
          'precision': make_scorer(precision_score),
          'recall': make_scorer(recall_score),
          'f1_score' : make_scorer(f1_score)
          }
```

In [ ]:

```
#define KFold

k_folds = KFold(n_splits = 5, random_state=42, shuffle=True)
```

In [ ]:

```
#cross validate on training set to check model stability

cv_scores_w2v_text_mnb = cross_validate(mnb, x_train_scaled, y_train, cv = k_folds, scoring=scorer)
```

In [ ]:

```
#check cross validation scores

cv_scores_w2v_text_mnb
```

```
Out[ ]: {'fit_time': array([0.07380009, 0.05881214, 0.05884242, 0.0538559 , 0.05684781]),
         'score_time': array([0.02393651, 0.02593064, 0.02393484, 0.02194166, 0.02792668]),
         'test_accuracy': array([0.67004147, 0.6788241 , 0.67829694, 0.67024521, 0.67829694]),
         'test_precision': array([0.83497191, 0.83143049, 0.82568807, 0.83367698, 0.81806283]),
         'test_recall': array([0.32495217, 0.34198895, 0.34701184, 0.33015787, 0.34635633]),
         'test_f1_score': array([0.46783396, 0.48463496, 0.4886562 , 0.47299669, 0.48666537])}
```

```
In [ ]: #fit model on the whole training set
        start = process_time()

        mnb.fit(x_train_scaled, y_train)

        end=process_time()
```

```
In [ ]: #test model on test set

        y_pred = mnb.predict(x_test_scaled)
```

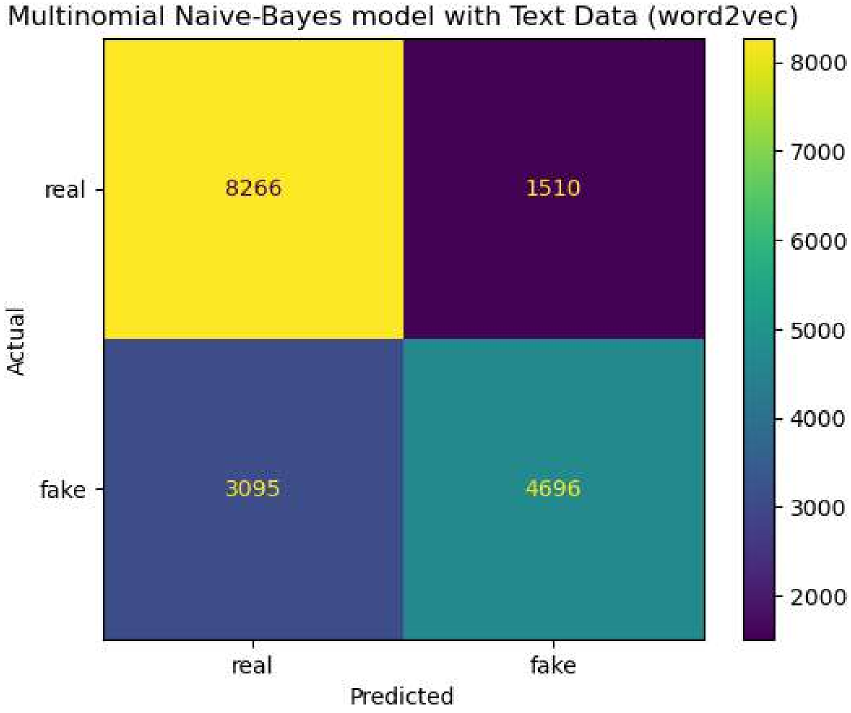
```
In [ ]: #view classification report

        print(classification_report(y_pred, y_test))
```

```
              precision    recall  f1-score   support

           0       0.85      0.73      0.78     11361
           1       0.60      0.76      0.67      6206

    accuracy                           0.74     17567
   macro avg       0.72      0.74      0.73     17567
weighted avg       0.76      0.74      0.74     17567
```

```
In [ ]: #view confusion matrix

        conf_matrix=confusion_matrix(y_test, y_pred)
```

```
In [ ]: cm_plot = ConfusionMatrixDisplay(conf_matrix, display_labels = ['real', 'fake'])
        cm_plot.plot(values_format='')
        cm_plot.ax_.set(
                        title='Multinomial Naive-Bayes model with Text Data (word2vec)',
                        xlabel='Predicted',
                        ylabel='Actual')
```

```
Out[ ]: [Text(0.5, 1.0, 'Multinomial Naive-Bayes model with Text Data (word2vec)'),
         Text(0.5, 0, 'Predicted'),
         Text(0, 0.5, 'Actual')]
```



```
In [ ]: accuracy=accuracy_score(y_test, y_pred)
        precision=precision_score(y_test, y_pred)
        recall=recall_score(y_test, y_pred)
```

```
f1=f1_score(y_test, y_pred)
fit_time=end-start
```

In [ ]:

```
dict = {'data type': 'text',
        'model type':'multinomial Naive-Bayes',
        'vectorize type':'word2vec',
        'accuracy': accuracy,
        'precision': precision,
        'recall': recall,
        'f1': f1,
        'fit time': fit_time
       }
```

In [ ]:

```
w2v_text_mnb=pd.DataFrame.from_dict([dict])
```

In [ ]:

```
w2v_text_mnb
```

Out[ ]:

	data type	model type	vectorize type	accuracy	precision	recall	f1	fit time
0	text	multinomial Naive-Bayes	word2vec	0.737861	0.756687	0.602747	0.671001	0.03125

In [ ]:

```
#save results for later use

%store w2v_text_mnb
```

```
Stored 'w2v_text_mnb' (DataFrame)
```

Gaussian NB

In [ ]:

```
#define model

gnb = GaussianNB()
```

In [ ]:

```
#define scoring metrics for cross validation

scorer = {'accuracy': make_scorer(accuracy_score),
          'precision': make_scorer(precision_score),
          'recall': make_scorer(recall_score),
          'f1_score' : make_scorer(f1_score)
          }
```

In [ ]:

```
#define KFold

k_folds = KFold(n_splits = 5, random_state=42, shuffle=True)
```

In [ ]:

```
#cross validate on training set to check model stability

cv_scores_w2v_text_gnb = cross_validate(gnb, x_train, y_train, cv = k_folds, scoring=scorer)
```

In [ ]:

```
#check cross validation scores

cv_scores_w2v_text_gnb
```

Out[ ]:

```
{'fit_time': array([0.09574389, 0.07978344, 0.08078289, 0.08577037, 0.08676767]),
 'score_time': array([0.05684805, 0.05385637, 0.07380462, 0.0598402 , 0.05385661]),
 'test_accuracy': array([0.76262503, 0.76286899, 0.76625595, 0.76308406, 0.75710626]),
 'test_precision': array([0.74576758, 0.73779796, 0.73642128, 0.74028857, 0.72610397]),
 'test_recall': array([0.71030336, 0.71823204, 0.73561002, 0.726184  , 0.719867  ]),
 'test_f1_score': array([0.72760358, 0.72788354, 0.73601543, 0.73316845, 0.72297203])}
```

In [ ]:

```
#fit model on the whole training set
start = process_time()

gnb.fit(x_train, y_train)

end=process_time()
```

In [ ]:

```
#test model on test set

y_pred2 = gnb.predict(x_test)
```

In [ ]:

```
#view classification report

print(classification_report(y_pred2, y_test))
```

```
              precision    recall  f1-score   support

           0       0.79      0.78      0.79      9893
           1       0.72      0.73      0.73      7674

    accuracy                           0.76     17567
   macro avg       0.76      0.76      0.76     17567
weighted avg       0.76      0.76      0.76     17567
```

In [ ]:

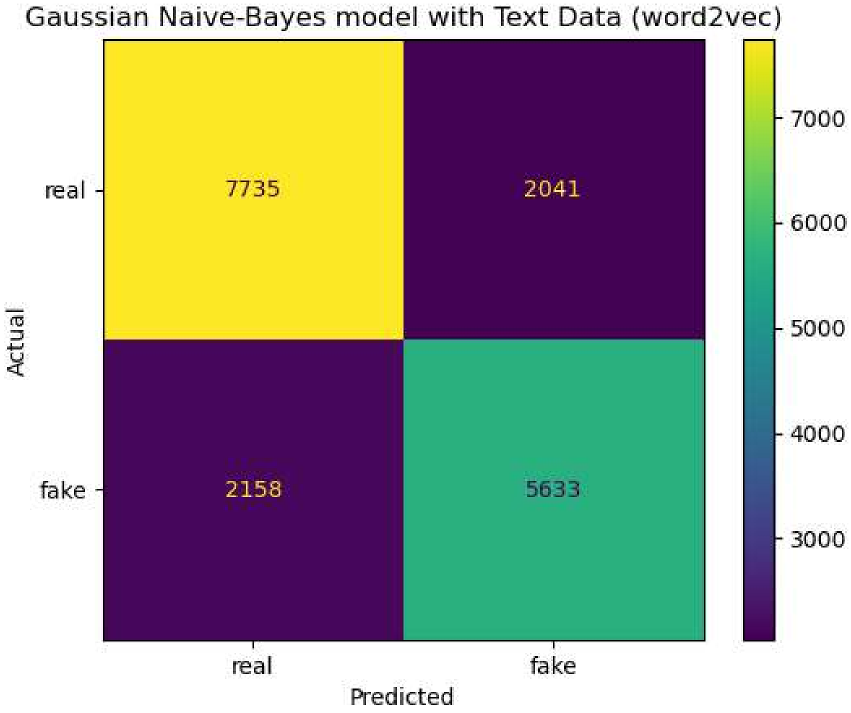
```
#view confusion matrix

conf_matrix=confusion_matrix(y_test, y_pred2)
```

In [ ]:

```
cm_plot = ConfusionMatrixDisplay(conf_matrix, display_labels = ['real', 'fake'])
cm_plot.plot(values_format='')
cm_plot.ax_.set(
                title='Gaussian Naive-Bayes model with Text Data (word2vec)',
                xlabel='Predicted',
                ylabel='Actual')
```

Out[ ]:

```
[Text(0.5, 1.0, 'Gaussian Naive-Bayes model with Text Data (word2vec)'),
 Text(0.5, 0, 'Predicted'),
 Text(0, 0.5, 'Actual')]
```



In [ ]:

```
accuracy=accuracy_score(y_test, y_pred2)
precision=precision_score(y_test, y_pred2)
recall=recall_score(y_test, y_pred2)
f1=f1_score(y_test, y_pred2)
fit_time=end-start
```

In [ ]:

```
dict = {'data type': 'text',
        'model type':'gaussian Naive-Bayes',
        'vectorize type':'word2vec',
        'accuracy': accuracy,
        'precision': precision,
        'recall': recall,
        'f1': f1,
        'fit time': fit_time
       }
```

In [ ]:

```
w2v_text_gnb=pd.DataFrame.from_dict([dict])
```

In [ ]:

```
w2v_text_gnb
```

Out[ ]:

	data type	model type	vectorize type	accuracy	precision	recall	f1	fit time
0	text	gaussian Naive-Bayes	word2vec	0.760972	0.734037	0.723014	0.728484	0.09375

In [ ]:

```
#save results for later use

%store w2v_text_gnb
```

```
Stored 'w2v_text_gnb' (DataFrame)
```