Practical_Phase1

March 6, 2022

```
[ ]: ## Practical Phase1
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     ## Stu No: 99210259
```

1 Download Required Packages

```
[ ]: !gdown --id 15JJ6ZysFM57tlUjXo2nHVhkGwePbVMVV
```

```
Downloading…
From: https://drive.google.com/uc?id=15JJ6ZysFM57tlUjXo2nHVhkGwePbVMVV
To: /content/dataset.csv
59.7MB [00:00, 97.0MB/s]
```

```
[ ]: !pip install contractions
     !pip install unidecode
     !pip install word2number
```

```
Collecting contractions
  Downloading contractions-0.0.52-py2.py3-none-any.whl (7.2 kB)
Collecting textsearch>=0.0.21
  Downloading textsearch-0.0.21-py2.py3-none-any.whl (7.5 kB)
Collecting pyahocorasick
  Downloading pyahocorasick-1.4.2.tar.gz (321 kB)
     |                 | 321 kB 5.7 MB/s
Collecting anyascii
  Downloading anyascii-0.2.0-py3-none-any.whl (283 kB)
     |                 | 283 kB 35.9 MB/s
Building wheels for collected packages: pyahocorasick
  Building wheel for pyahocorasick (setup.py) … done
  Created wheel for pyahocorasick:
filename=pyahocorasick-1.4.2-cp37-cp37m-linux_x86_64.whl size=85440
sha256=eea7fcd5669f224c651f81dd0d9f3191da0400bafd1a714cb9206c0f38f0af2c
  Stored in directory: /root/.cache/pip/wheels/25/19/a6/8f363d9939162782bb8439d8
86469756271abc01f76fbd790f
Successfully built pyahocorasick
Installing collected packages: pyahocorasick, anyascii, textsearch, contractions
```

```
Successfully installed anyascii-0.2.0 contractions-0.0.52 pyahocorasick-1.4.2
textsearch-0.0.21
Collecting unidecode
  Downloading Unidecode-1.2.0-py2.py3-none-any.whl (241 kB)
     |                  | 241 kB 5.4 MB/s
Installing collected packages: unidecode
Successfully installed unidecode-1.2.0
Collecting word2number
  Downloading word2number-1.1.zip (9.7 kB)
Building wheels for collected packages: word2number
  Building wheel for word2number (setup.py) … done
  Created wheel for word2number: filename=word2number-1.1-py3-none-any.whl
size=5581
sha256=2280688a40803ead93d0b281a4597cbc5002a70afc345b4be2f91aa7d3c99392
  Stored in directory: /root/.cache/pip/wheels/4b/c3/77/a5f48aeb0d3efb7cd5ad61cb
d3da30bbf9ffc9662b07c9f879
Successfully built word2number
Installing collected packages: word2number
Successfully installed word2number-1.1
```

1.1 Imports

[ ]:

```
import pandas as pd
import numpy as np
import sklearn
from sklearn.model_selection import train_test_split


#for bag of words
from sklearn.feature_extraction.text import CountVectorizer


#these are all for preprocessing
import nltk
from nltk.tokenize import word_tokenize
import re
from bs4 import BeautifulSoup
import spacy
import unidecode
from word2number import w2n
import contractions

from nltk.corpus import stopwords
from nltk.stem import WordNetLemmatizer
# this is required for word_tokenize
nltk.download('punkt')
nltk.download('stopwords')
nltk.download('wordnet')
```

```
[nltk_data] Downloading package punkt to /root/nltk_data…
[nltk_data]   Unzipping tokenizers/punkt.zip.
[nltk_data] Downloading package stopwords to /root/nltk_data…
[nltk_data]   Unzipping corpora/stopwords.zip.
[nltk_data] Downloading package wordnet to /root/nltk_data…
[nltk_data]   Unzipping corpora/wordnet.zip.
```

[ ]:
```
True
```

1.2 Preprocessing Text Functions

[ ]:
```
def remove_all_non_alphabetic(text):
  return re.sub('[^A-Za-z]',' ',text)

def strip_html_tags(text):
    """remove html tags from text"""
    soup = BeautifulSoup(text, "html.parser")
    stripped_text = soup.get_text(separator=" ")
    return stripped_text

def remove_accented_chars(text):
    """remove accented characters from text, e.g. café"""
    text = unidecode.unidecode(text)
    return text

stop_words = set(stopwords.words('english'))
def remove_stop_words(token):
  return [item for item in token if item not in stop_words]

lemma = WordNetLemmatizer()
def lemmatization(token):
  return [lemma.lemmatize(word=w,pos='v') for w in token]

def clean_length(token):
  return [item for item in token if len(item)>2]

def punctuation_removal(text):
    return re.sub(r'[\.\?\!\,\:\;\"]', '', text)

def text_merge(token):
  return ' '.join([i for i in token if not i.isdigit()])
```

2 Split the data

[ ]:

```
raw_data = pd.read_csv('dataset.csv')
raw_data['sentiment'] = raw_data['sentiment'].apply(lambda input: 1 if input ==␣
 ↪'positive' else 0)

#0 means unprocessed
X_train_0,X_test_0,y_train,y_test=train_test_split(raw_data['comment'],raw_data['sentiment'],t
 ↪2)

# 1 means one level of pre-processing
X_train_1,X_test_1=X_train_0.copy(),X_test_0.copy()

# 2 means two level of pre-processing
X_train_2,X_test_2=X_train_0.copy(),X_test_0.copy()
```

2.1 Preprocess Data

[ ]:

```
def process_level1(data):
    return (data.apply(str.lower)
                .apply(remove_all_non_alphabetic)
                .apply(word_tokenize)
                .apply(text_merge))

def process_level2(data):
    return (data.apply(str.lower)
        .apply(contractions.fix)
        .apply(strip_html_tags)
        .apply(remove_accented_chars)
        .apply(remove_all_non_alphabetic)
        .apply(word_tokenize)
        .apply(remove_stop_words)
        .apply(lemmatization)
        .apply(clean_length)
        .apply(text_merge))
```

[ ]:

```
X_train_1 = process_level1(X_train_1)
X_test_1 = process_level1(X_test_1)

X_train_2 = process_level2(X_train_2)
X_test_2 = process_level2(X_test_2)
```

2.2 Bag of Words Representation

[ ]:
```
def convert_to_BOW(train,test):
    vectorizer = CountVectorizer(max_df=0.4,min_df=0.01,lowercase=False)
    X_train_transformed = vectorizer.fit_transform(train)
    X_test_transformed = vectorizer.transform(test)
    return X_train_transformed,X_test_transformed
```

[ ]:
```
X_train_0_BOW,X_test_0_BOW = convert_to_BOW(X_train_0,X_test_0)
X_train_1_BOW,X_test_1_BOW = convert_to_BOW(X_train_1,X_test_1)
X_train_2_BOW,X_test_2_BOW = convert_to_BOW(X_train_2,X_test_2)
```

[ ]:
```
X_train_0_BOW
```

[ ]:
```
<36000x1807 sparse matrix of type '<class 'numpy.int64'>'
        with 2787010 stored elements in Compressed Sparse Row format>
```

[ ]:
```

```

3 Models

3.1 1- Regression Model

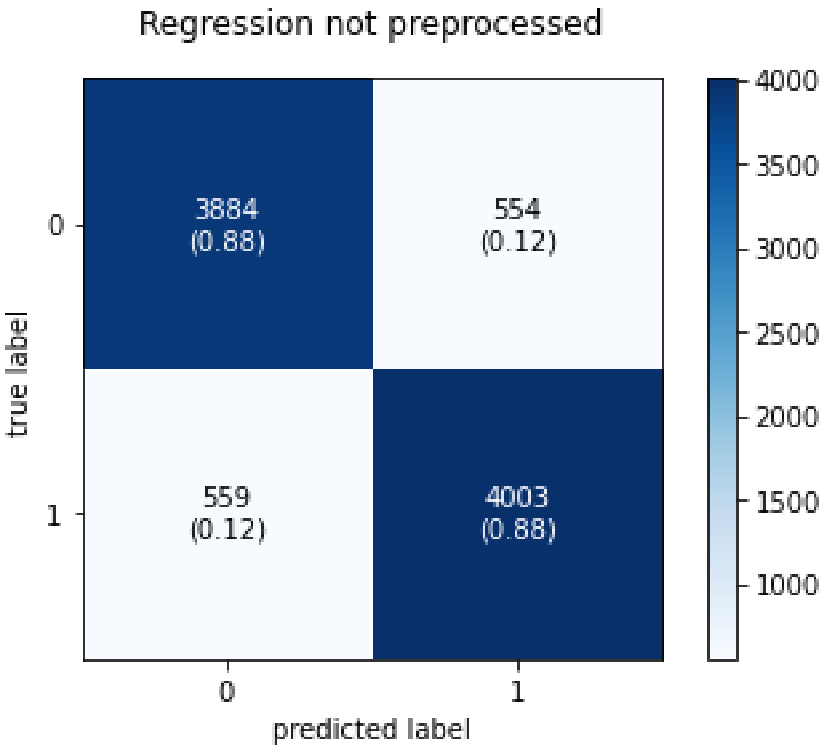
[ ]:
```
import warnings
warnings.filterwarnings("ignore", category=DeprecationWarning)

def warn(*args, **kwargs):
    pass
import warnings
warnings.warn = warn
```

[ ]:
```
from mlxtend.plotting import plot_confusion_matrix
from sklearn.metrics import confusion_matrix as cm
from sklearn.metrics import classification_report
import matplotlib.pyplot as plt
def print_confusion_matrix(y_test,y_prediction,title):
    print(classification_report(y_test,y_prediction))
    matrix = cm(y_test,y_prediction)
    fig, ax = plot_confusion_matrix(conf_mat=matrix,
                                    show_absolute=True,
                                    show_normed=True,
                                    colorbar=True)

    plt.title(title)
    plt.show()
```

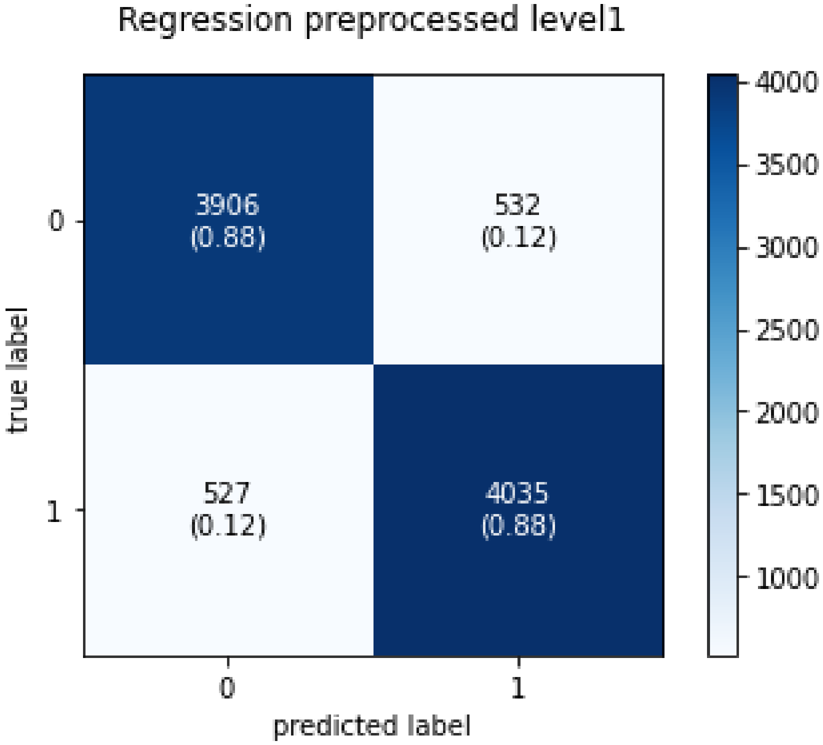
```
[ ]: from sklearn.linear_model import LogisticRegression

     def regression(X_train,X_test,y_train,**kwarg):
         clf = LogisticRegression(**kwarg).fit(X_train, y_train)
         return clf.predict(X_test),clf
```

```
[ ]: print_confusion_matrix(y_test,regression(X_train_0_BOW,X_test_0_BOW,y_train)[0],'Regression␣
      ↪not preprocessed')
     print_confusion_matrix(y_test,regression(X_train_1_BOW,X_test_1_BOW,y_train)[0],'Regression␣
      ↪preprocessed level1')
     print_confusion_matrix(y_test,regression(X_train_2_BOW,X_test_2_BOW,y_train)[0],'Regression␣
      ↪preprocessed level2')
```

```
              precision    recall  f1-score   support

           0       0.87      0.88      0.87      4438
           1       0.88      0.88      0.88      4562

    accuracy                           0.88      9000
   macro avg       0.88      0.88      0.88      9000
weighted avg       0.88      0.88      0.88      9000
```

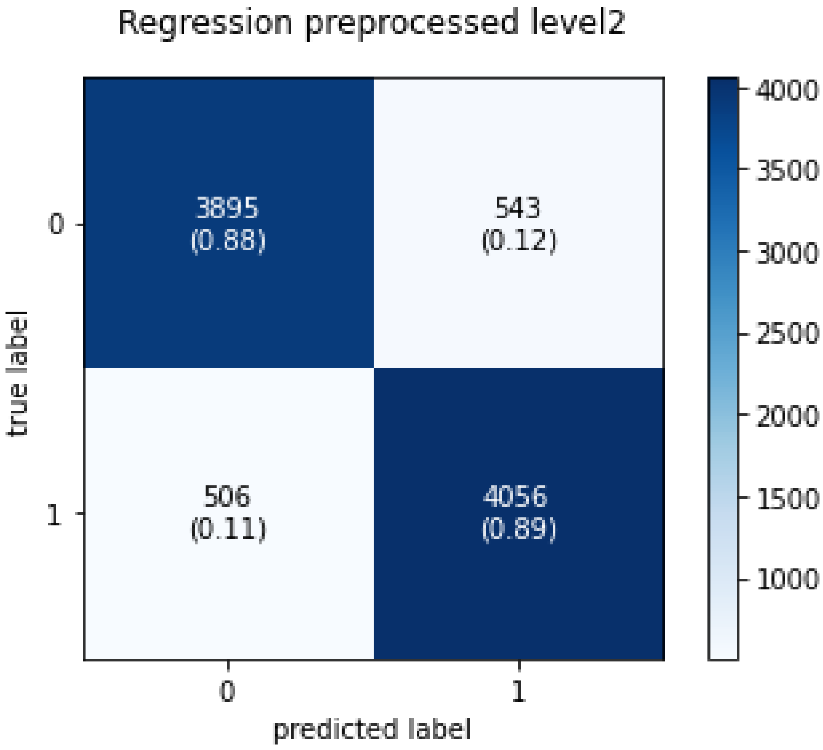


```
              precision    recall  f1-score   support

           0       0.88      0.88      0.88      4438
           1       0.88      0.88      0.88      4562

    accuracy                           0.88      9000
   macro avg       0.88      0.88      0.88      9000
weighted avg       0.88      0.88      0.88      9000
```



Regression preprocessed level1

```
              precision    recall  f1-score   support

           0       0.89      0.88      0.88      4438
           1       0.88      0.89      0.89      4562

    accuracy                           0.88      9000
   macro avg       0.88      0.88      0.88      9000
weighted avg       0.88      0.88      0.88      9000
```



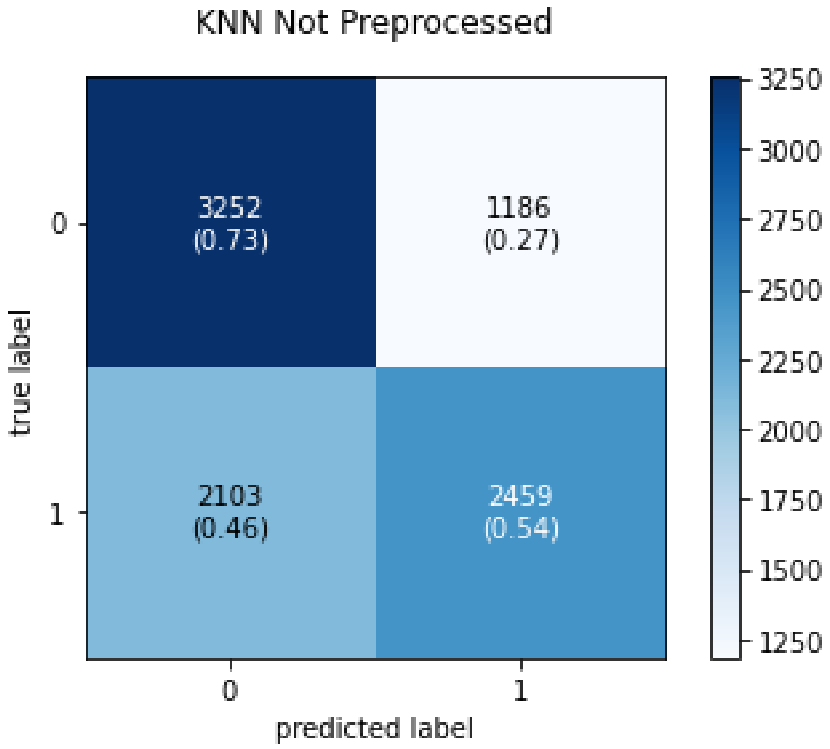
3.2 2- KNN Model

```
[ ]: from sklearn.neighbors import KNeighborsClassifier
     def knn(X_train,X_test,y_train):
         neigh = KNeighborsClassifier(n_neighbors=5)
         neigh.fit(X_train, y_train)
         return neigh.predict(X_test),neigh
```

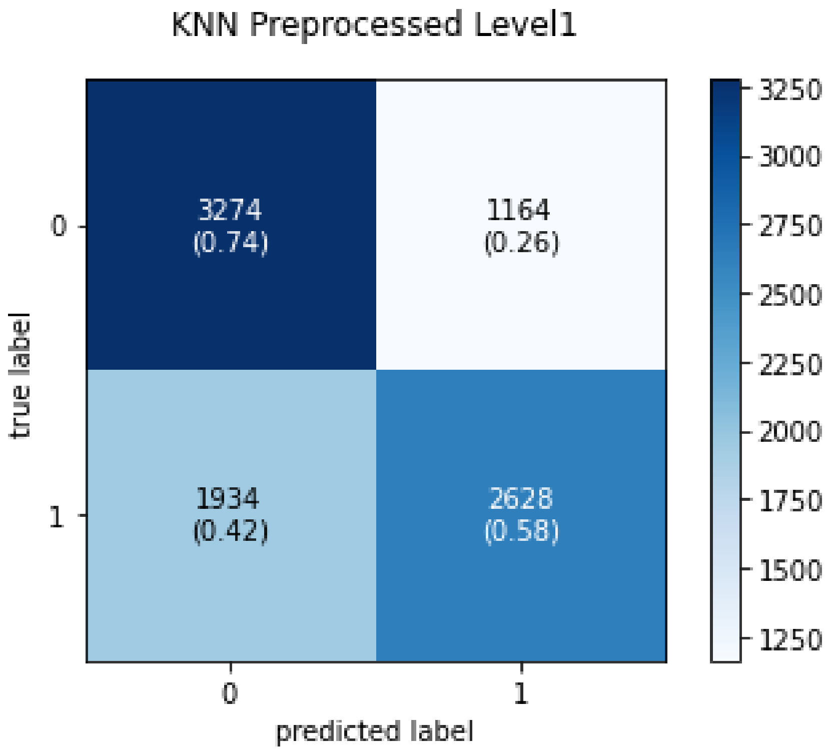
```
[ ]: print_confusion_matrix(y_test,knn(X_train_0_BOW,X_test_0_BOW,y_train)[0],'KNN␣
      ↪Not Preprocessed')
     print_confusion_matrix(y_test,knn(X_train_1_BOW,X_test_1_BOW,y_train)[0],'KNN␣
      ↪Preprocessed Level1')
     print_confusion_matrix(y_test,knn(X_train_2_BOW,X_test_2_BOW,y_train)[0],'KNN␣
      ↪Preprocessed Level2')
```

```
              precision    recall  f1-score   support

           0       0.61      0.73      0.66      4438
           1       0.67      0.54      0.60      4562

    accuracy                           0.63      9000
   macro avg       0.64      0.64      0.63      9000
```

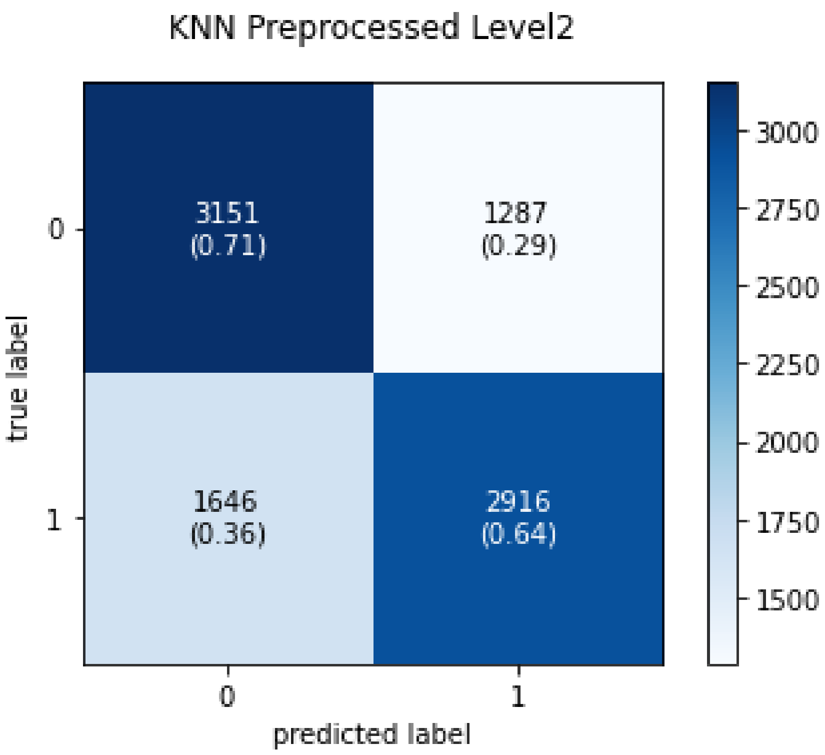
```
weighted avg       0.64      0.63      0.63      9000
```



```
              precision    recall  f1-score   support

           0       0.63      0.74      0.68      4438
           1       0.69      0.58      0.63      4562

    accuracy                           0.66      9000
   macro avg       0.66      0.66      0.65      9000
weighted avg       0.66      0.66      0.65      9000
```



```
              precision    recall  f1-score   support

           0       0.66      0.71      0.68      4438
           1       0.69      0.64      0.67      4562

    accuracy                           0.67      9000
   macro avg       0.68      0.67      0.67      9000
weighted avg       0.68      0.67      0.67      9000
```



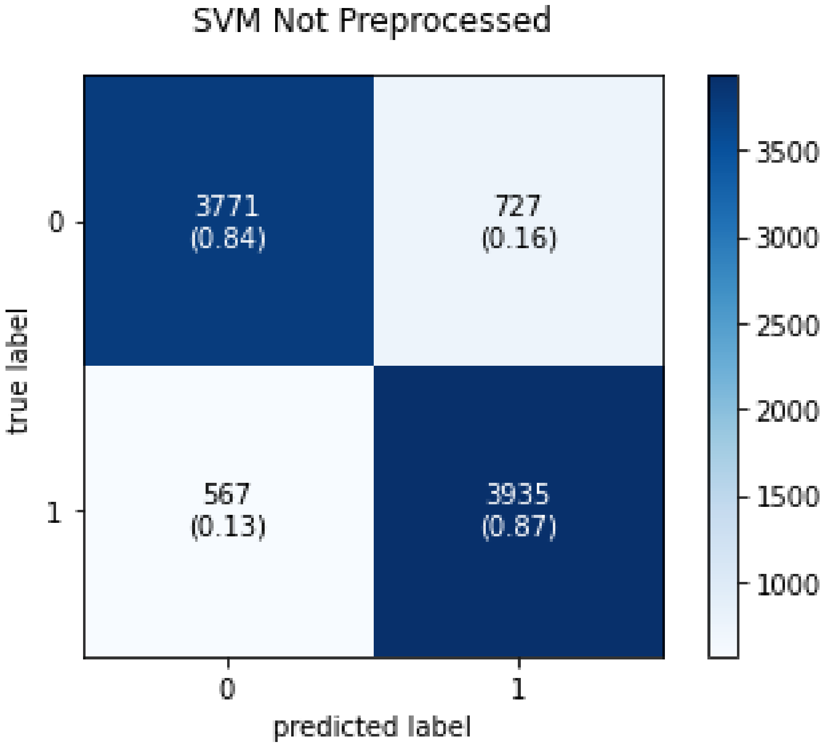
3.3 3- SVM Model

[ ]:
```
from sklearn.svm import SVC
from sklearn.pipeline import make_pipeline
def svm(X_train,X_test,y_train):
    clf = make_pipeline( SVC(gamma='auto'))
    clf.fit(X_train, y_train)
    return clf.predict(X_test),clf
```

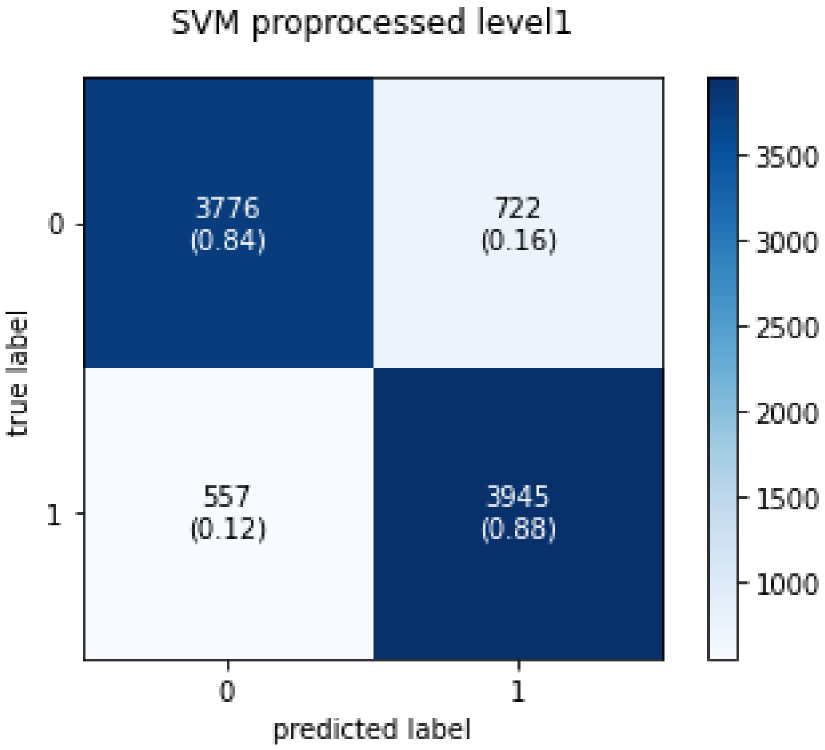
[ ]:
```
print_confusion_matrix(y_test,svm(X_train_0_BOW,X_test_0_BOW,y_train)[0],'SVM␣
 ↪Not Preprocessed')
print_confusion_matrix(y_test,svm(X_train_1_BOW,X_test_1_BOW,y_train)[0],'SVM␣
 ↪proprocessed level1')
print_confusion_matrix(y_test,svm(X_train_2_BOW,X_test_2_BOW,y_train)[0],'SVM␣
 ↪preprocessed level2')
```

```
              precision    recall  f1-score   support

           0       0.87      0.84      0.85      4498
           1       0.84      0.87      0.86      4502

    accuracy                           0.86      9000
```

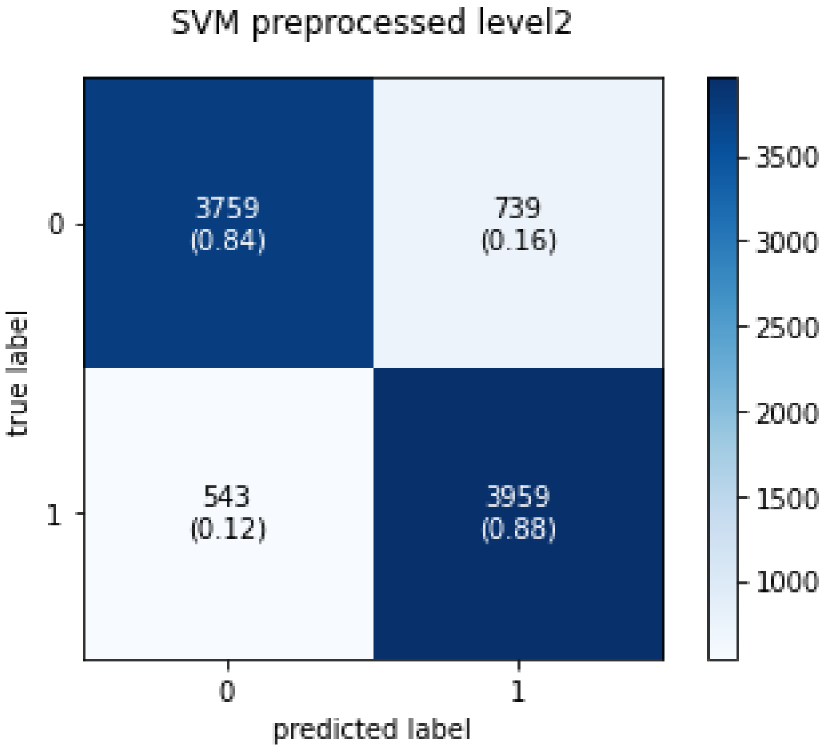
```
   macro avg       0.86      0.86      0.86      9000
weighted avg       0.86      0.86      0.86      9000
```



```
              precision    recall  f1-score   support

           0       0.87      0.84      0.86      4498
           1       0.85      0.88      0.86      4502

    accuracy                           0.86      9000
   macro avg       0.86      0.86      0.86      9000
weighted avg       0.86      0.86      0.86      9000
```



```
              precision    recall  f1-score   support

           0       0.87      0.84      0.85      4498
           1       0.84      0.88      0.86      4502

    accuracy                           0.86      9000
   macro avg       0.86      0.86      0.86      9000
weighted avg       0.86      0.86      0.86      9000
```



4 Word2Vector and HyperParameter Effect

```
[ ]: # https://www.kaggle.com/pierremegret/gensim-word2vec-tutorial
     # https://www.kaggle.com/kstathou/word-embeddings-logistic-regression
```

```
[ ]: import gensim.models

     w2v = gensim.models.Word2Vec( [row.split() for row in X_train_2],
                                   min_count=50,
                                  window=10,
                                  size=300)
```

```
[ ]: w2v.most_similar('king')
```

```
[ ]: [('lion', 0.7712827324867249),
      ('stephen', 0.7464975118637085),
      ('solomon', 0.7280431985855103),
      ('lord', 0.706125020980835),
      ('legend', 0.6681618094444275),
      ('princess', 0.6676332950592041),
      ('kings', 0.6650164127349854),
      ('rice', 0.6360715627670288),
      ('queen', 0.6311061978340149),
      ('immortal', 0.6231356859207153)]
```

```
[ ]: def document_vector(doc):
         doc = [word for word in doc.split() if word in w2v.wv.vocab]
         return np.mean(w2v[doc], axis=0)
```

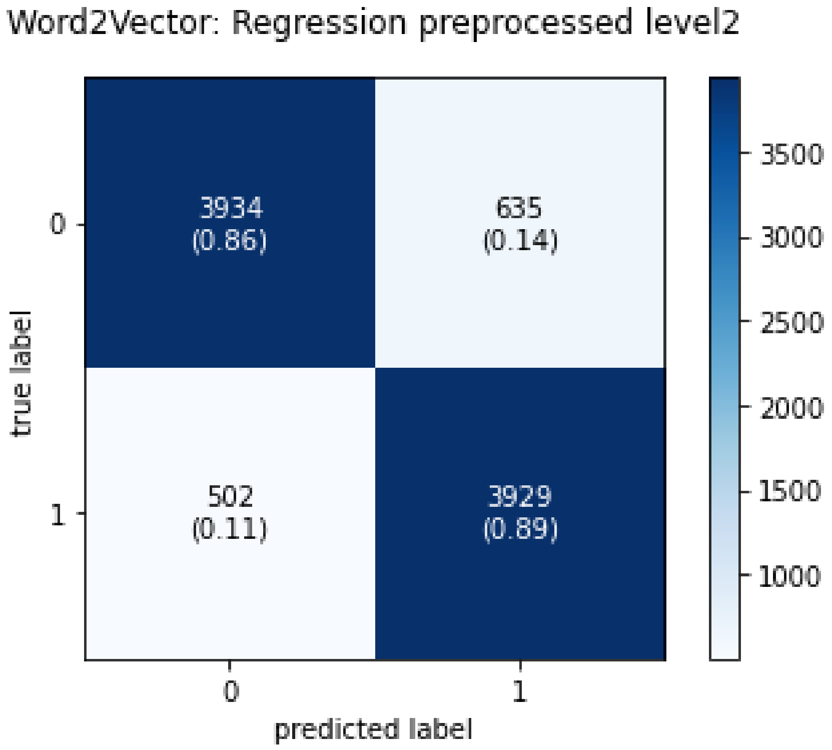
```
[ ]: X_train_w2v = X_train_2.apply(document_vector)
     X_test_w2v = X_test_2.apply(document_vector)
```

```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:3:
DeprecationWarning: Call to deprecated `__getitem__` (Method will be removed in
4.0.0, use self.wv.__getitem__() instead).
  This is separate from the ipykernel package so we can avoid doing imports
until
```

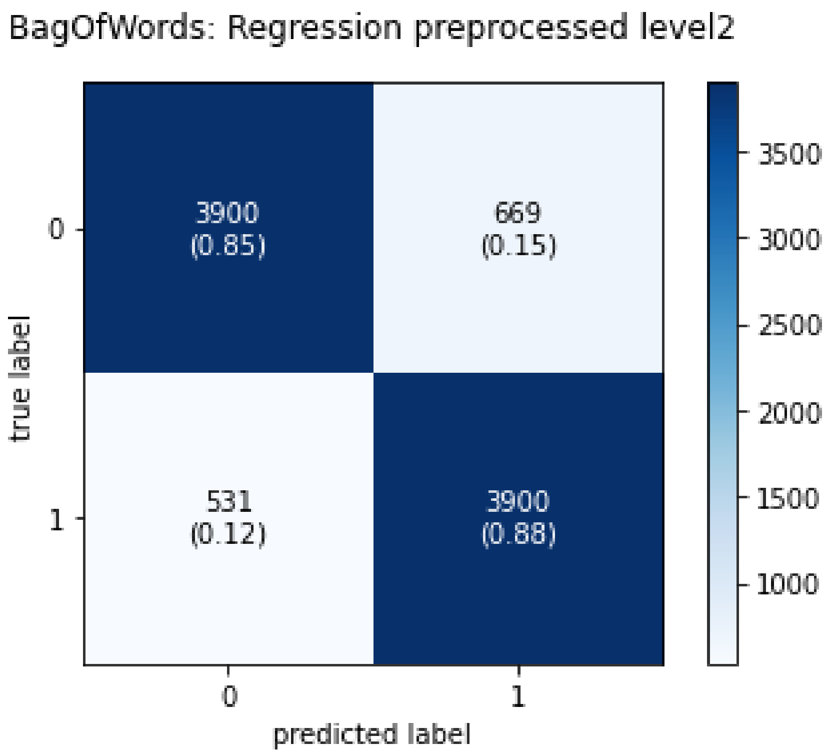
4.1 Logistic Regression

```
[ ]: lr_w2v_pred,regression_w2v =␣
      ↪regression(list(X_train_w2v),list(X_test_w2v),y_train,
                                                  C=150,max_iter=10000)
     print_confusion_matrix(y_test,lr_w2v_pred,'Word2Vector: Regression preprocessed␣
      ↪level2')

     lr_bow_pred,regression_BOW = regression(X_train_2_BOW,X_test_2_BOW,y_train)
     print_confusion_matrix(y_test,lr_bow_pred,'BagOfWords: Regression preprocessed␣
      ↪level2')
```

```
              precision    recall  f1-score   support

           0       0.89      0.86      0.87      4569
           1       0.86      0.89      0.87      4431

    accuracy                           0.87      9000
   macro avg       0.87      0.87      0.87      9000
weighted avg       0.87      0.87      0.87      9000
```



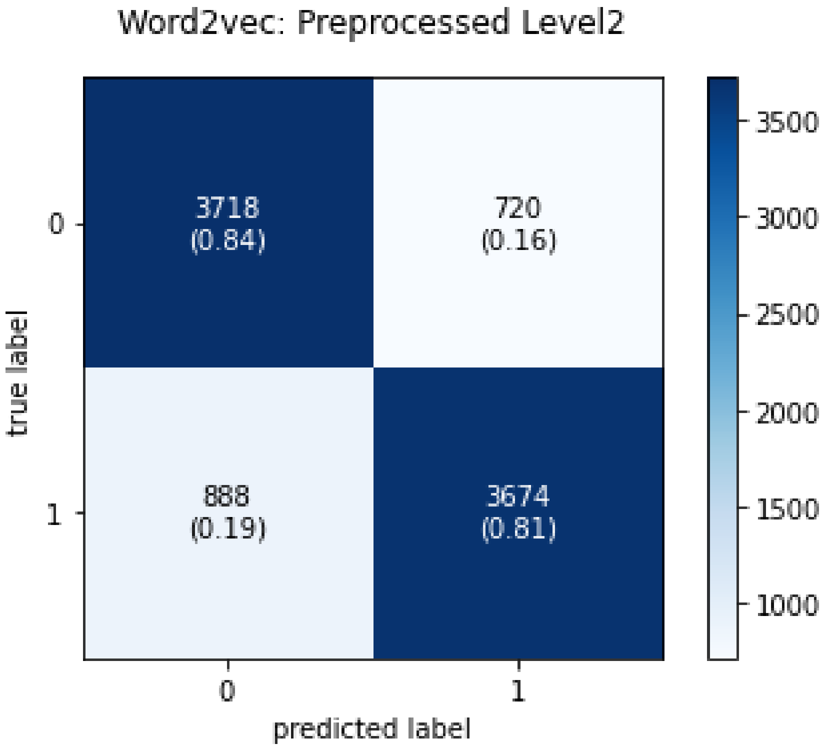
```
              precision    recall  f1-score   support

           0       0.88      0.85      0.87      4569
           1       0.85      0.88      0.87      4431

    accuracy                           0.87      9000
   macro avg       0.87      0.87      0.87      9000
weighted avg       0.87      0.87      0.87      9000
```



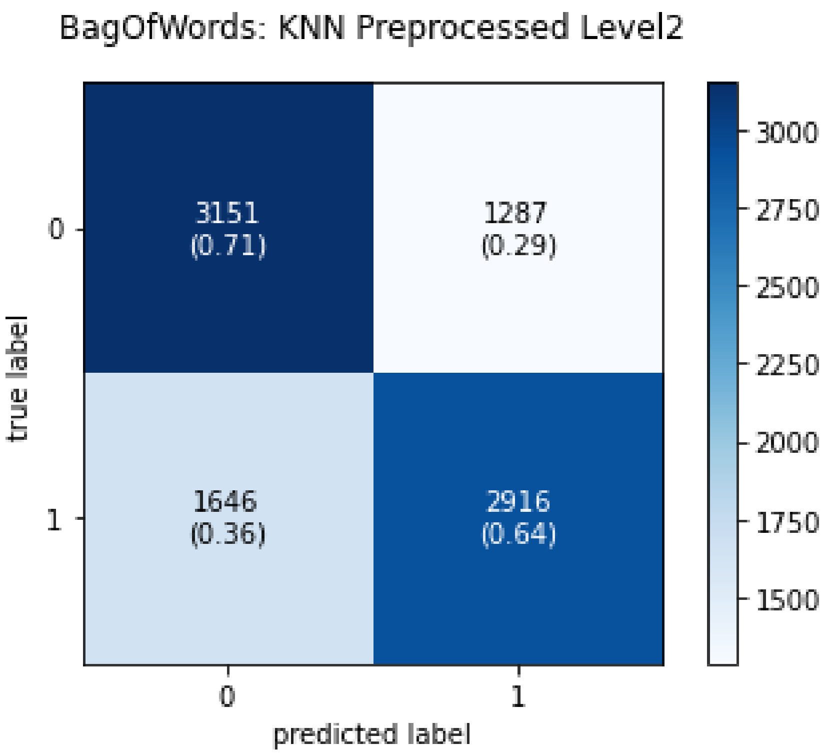
4.2 KNN

```
[ ]: knn_w2v_pred,knn_w2v = knn(list(X_train_w2v),list(X_test_w2v),y_train)

     print_confusion_matrix(y_test,knn_w2v_pred,'Word2vec: Preprocessed Level2')

     knn_bow_pred,knn_bow = knn(X_train_2_BOW,X_test_2_BOW,y_train)
     print_confusion_matrix(y_test,knn_bow_pred,'BagOfWords: KNN Preprocessed␣
      ↪Level2')
```

```
              precision    recall  f1-score   support

           0       0.81      0.84      0.82      4438
           1       0.84      0.81      0.82      4562

    accuracy                           0.82      9000
   macro avg       0.82      0.82      0.82      9000
weighted avg       0.82      0.82      0.82      9000
```



```
              precision    recall  f1-score   support

           0       0.66      0.71      0.68      4438
           1       0.69      0.64      0.67      4562

    accuracy                           0.67      9000
   macro avg       0.68      0.67      0.67      9000
weighted avg       0.68      0.67      0.67      9000
```

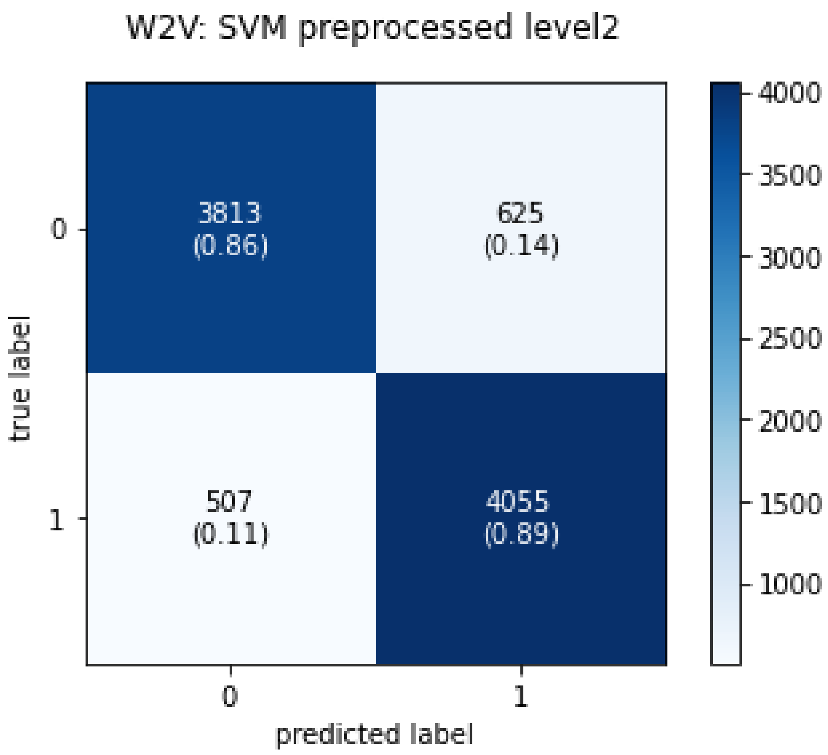


4.3 SVM

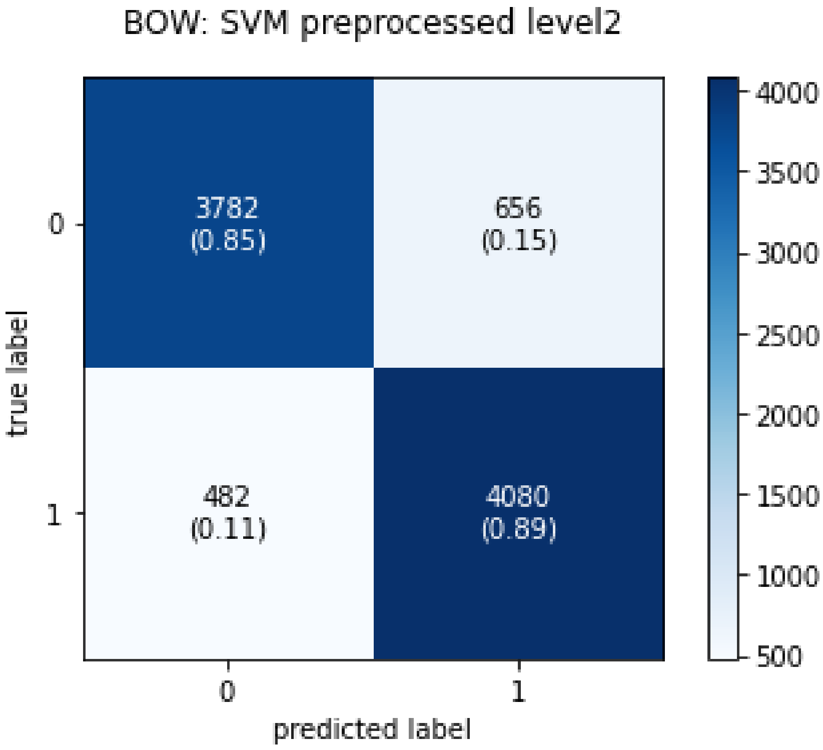
[ ]:

```
svm_w2v_pred,svm_w2v=svm(list(X_train_w2v),list(X_test_w2v),y_train)
svm_bow_pred,svm_bow = svm(X_train_2_BOW,X_test_2_BOW,y_train)

print_confusion_matrix(y_test,svm_w2v_pred,'W2V: SVM preprocessed level2')
print_confusion_matrix(y_test,svm_bow_pred,'BOW: SVM preprocessed level2')
```

```
              precision    recall  f1-score   support

           0       0.88      0.86      0.87      4438
           1       0.87      0.89      0.88      4562

    accuracy                           0.87      9000
   macro avg       0.87      0.87      0.87      9000
weighted avg       0.87      0.87      0.87      9000
```



```
              precision    recall  f1-score   support

           0       0.89      0.85      0.87      4438
           1       0.86      0.89      0.88      4562

    accuracy                           0.87      9000
   macro avg       0.87      0.87      0.87      9000
weighted avg       0.87      0.87      0.87      9000
```



4.4 MLP

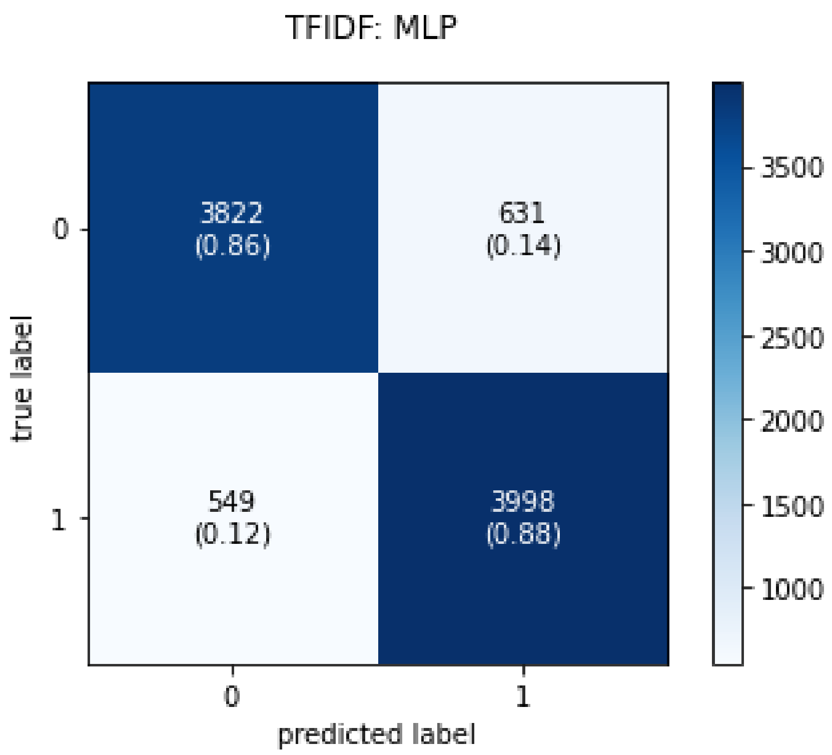
4.4.1 TF-IDF Vectorizer

[ ]:
```
from sklearn.feature_extraction.text import TfidfVectorizer
vectorizer = TfidfVectorizer( min_df=0.01,max_df=0.5)
X_train_2_tfidf=vectorizer.fit_transform(X_train_2)
X_test_2_tfidf = vectorizer.transform(X_test_2)
```

[ ]:
```
from sklearn.neural_network import MLPClassifier
from sklearn.model_selection import GridSearchCV

grid = {
    'hidden_layer_sizes':[(80),(70,),(40,10),(90)],
}
mlp = MLPClassifier(learning_rate='adaptive',solver='adam')
mlp_cv = GridSearchCV (estimator=mlp,param_grid=grid,cv=2)

mlp_cv.fit(X_train_2_tfidf,y_train)

mlp_prediction=mlp_cv.predict(X_test_2_tfidf)
```

```
print_confusion_matrix(y_test,mlp_prediction,'TFIDF: MLP ')
```

```
{'mean_fit_time': array([110.42653728, 104.80755305,  37.31890857,
109.83874869]), 'std_fit_time': array([3.38637757, 0.72014499, 2.2723614 ,
1.20505762]), 'mean_score_time': array([0.14038301, 0.12818861, 0.07941163,
0.14955759]), 'std_score_time': array([0.00110602, 0.00455904, 0.00154245,
0.00252771]), 'param_hidden_layer_sizes': masked_array(data=[80, (70,), (40,
10), 90],
             mask=[False, False, False, False],
       fill_value='?',
            dtype=object), 'params': [{'hidden_layer_sizes': 80},
{'hidden_layer_sizes': (70,)}, {'hidden_layer_sizes': (40, 10)},
{'hidden_layer_sizes': 90}], 'split0_test_score': array([0.85511111, 0.85561111,
0.84366667, 0.85822222]), 'split1_test_score': array([0.85838889, 0.85694444,
0.84683333, 0.85838889]), 'mean_test_score': array([0.85675   , 0.85627778,
0.84525   , 0.85830556]), 'std_test_score': array([1.63888889e-03,
6.66666667e-04, 1.58333333e-03, 8.33333333e-05]), 'rank_test_score': array([2,
3, 4, 1], dtype=int32)}
              precision    recall  f1-score   support

           0       0.87      0.86      0.87      4453
           1       0.86      0.88      0.87      4547

    accuracy                           0.87      9000
   macro avg       0.87      0.87      0.87      9000
weighted avg       0.87      0.87      0.87      9000
```



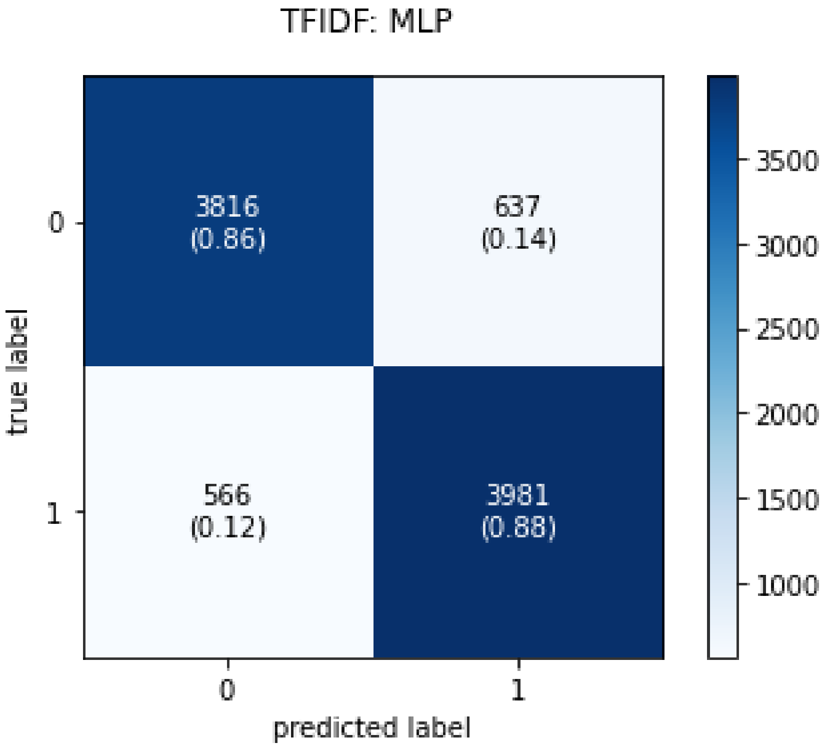
```
[ ]: pd.DataFrame(mlp_cv.cv_results_)
```

```
[ ]:    mean_fit_time  std_fit_time  …  std_test_score  rank_test_score
     0     110.426537      3.386378  …        0.001639                2
     1     104.807553      0.720145  …        0.000667                3
     2      37.318909      2.272361  …        0.001583                4
     3     109.838749      1.205058  …        0.000083                1

     [4 rows x 11 columns]
```

```
[ ]: mlp_90 =␣
      ↪MLPClassifier(learning_rate='adaptive',solver='adam',hidden_layer_sizes=(90))
     mlp_90.fit(X_train_2_tfidf,y_train)
     mlp_prediction=mlp_90.predict(X_test_2_tfidf)
     print_confusion_matrix(y_test,mlp_prediction,'TFIDF: MLP ')
```

```
              precision    recall  f1-score   support

           0       0.87      0.86      0.86      4453
           1       0.86      0.88      0.87      4547

    accuracy                           0.87      9000
   macro avg       0.87      0.87      0.87      9000
```

```
weighted avg       0.87      0.87      0.87      9000
```



5 Google Drive Save

```
[ ]: # Load the Drive helper and mount
     from google.colab import drive
     drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

```
[ ]: import scipy.sparse
     import numpy
     scipy.sparse.save_npz('/content/drive/MyDrive/DataForColob/ML_Project/
      ↪X_train_2_BOW',X_train_2_BOW)
     scipy.sparse.save_npz('/content/drive/MyDrive/DataForColob/ML_Project/
      ↪X_test_2_BOW',X_test_2_BOW)

     X_train_w2v.to_pickle('/content/drive/MyDrive/DataForColob/ML_Project/
      ↪X_train_w2v.pkl')
```

```
X_test_w2v.to_pickle('/content/drive/MyDrive/DataForColob/ML_Project/X_test_w2v.
 ↪pkl')

numpy.save("/content/drive/MyDrive/DataForColob/ML_Project/y_train", y_train)
numpy.save("/content/drive/MyDrive/DataForColob/ML_Project/y_test", y_test)
```

[ ]:

```
import pickle
pickle.dump(svm_w2v, open('/content/drive/MyDrive/DataForColob/ML_Project/SVM.
 ↪pkl', 'wb'))
pickle.dump(knn_w2v,open('/content/drive/MyDrive/DataForColob/ML_Project/KNN.
 ↪pkl', 'wb'))
pickle.dump(regression_w2v,open('/content/drive/MyDrive/DataForColob/ML_Project/
 ↪LR.pkl', 'wb'))
```

[ ]:

```
import pickle
pickle.dump(mlp_90,open('/content/drive/MyDrive/DataForColob/ML_Project/best.
 ↪pkl', 'wb'))
pickle.dump(vectorizer,open('/content/drive/MyDrive/DataForColob/ML_Project/
 ↪vectorizer.pkl', 'wb'))
```

[ ]:

```

```