ML PROJECT

Libraries

Main Libraries

```
import pandas as pd
import numpy as np
import sklearn as sk
```

Data Visualization

```
import matplotlib.pyplot as plt
import seaborn as sns
```

Text Preprocessing

```
import neattext.functions as nfx
import nltk
from nltk import word_tokenize
from nltk.stem import WordNetLemmatizer
from nltk import pos_tag

#nltk.download('wordnet') -> dependencies for nltk tokenization and
lemmatization
#nltk.download('omw-1.4')
#nltk.download('punkt')
#nltk.download('averaged_perceptron_tagger')
```

Pipelines

```
from sklearn.pipeline import Pipeline
```

Vectorizers And Transformers

```
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.feature_extraction.text import TfidfTransformer
```

Algorithms And Ensembles

```
from sklearn.svm import SVC
from sklearn.linear_model import SGDClassifier
from sklearn.naive_bayes import MultinomialNB
from sklearn.multiclass import OneVsRestClassifier
from sklearn.ensemble import StackingClassifier
```

Split Data

```
from sklearn.model_selection import train_test_split
```

Cross Validation

```
from sklearn.model_selection import cross_val_predict,
StratifiedKFold, cross_val_score
```

Metrics

```
from sklearn.metrics import classification_report, confusion_matrix
```

Parameter Tuning

```
from sklearn.model_selection import GridSearchCV
```

Get Data

```
df = pd.read_csv('train.csv')
```

```
df.head()
```

```
                                                text    emotion
0  Yeah for coupons!   Found this place randomly ...    neutral
1  i still love to feel a gentle breeze and hear ...  happiness
2  Normal, fama devido ao programa de tv. A sobre...    neutral
3                     im feeling a little less jaded    sadness
4  i have never shaken the feeling of ferocious p...       hate
```

Data Exploration

```
df.shape
```

```
(8000, 2)
```

```
df.dtypes
```

```
text       object
emotion    object
dtype: object
```

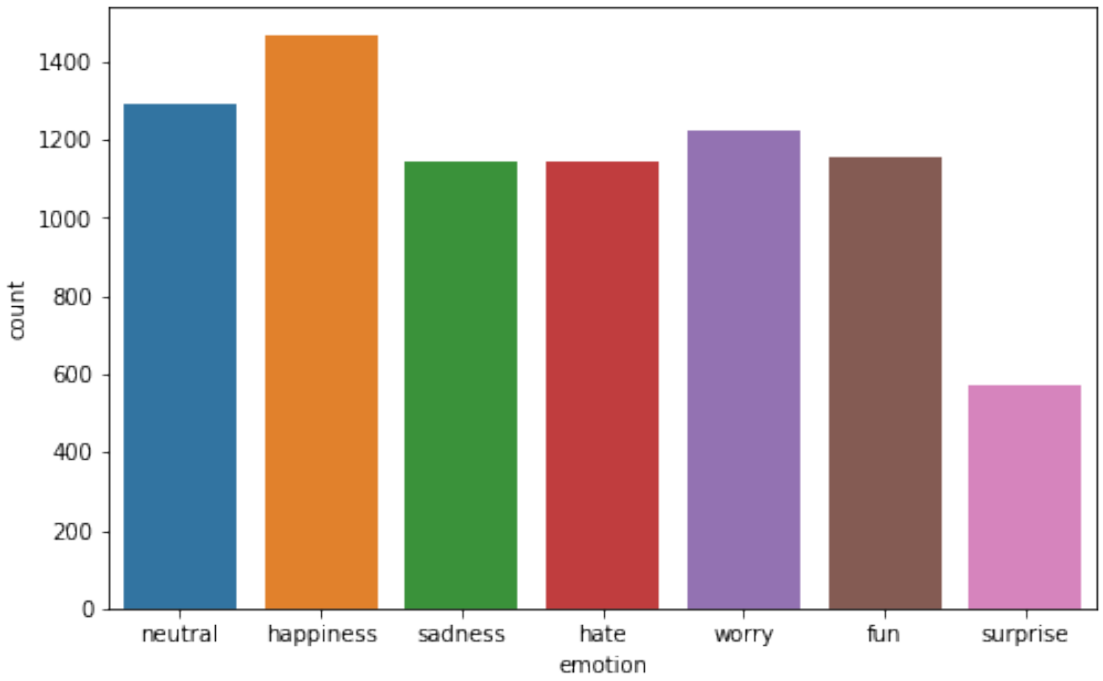
```
df.isnull().sum()
```

```
text       0
emotion    0
dtype: int64
```

```
df.groupby(['emotion']).count()
```

```
           text
emotion
fun        1157
happiness  1468
hate       1143
neutral    1292
sadness    1146
surprise    572
worry      1222
```

```
plt.figure(figsize=(8,5))
sns.countplot(x='emotion', data=df)
plt.show()
```



Encode Label

```
def define_class(emotion):
    if emotion == 'sadness':
        return 0
    elif emotion == 'neutral':
        return 1
    elif emotion == 'worry':
        return 2
    elif emotion == 'happiness':
        return 3
    elif emotion == 'fun':
        return 4
    elif emotion == 'surprise':
        return 5
    elif emotion == 'hate':
        return 6
    else:
        raise Exception('Not a valid emotion')

df['emotion_class'] = df['emotion'].apply(define_class)

df.head()
```

```
                                                text    emotion
emotion_class
0  Yeah for coupons!   Found this place randomly ...    neutral
1
1  i still love to feel a gentle breeze and hear ...  happiness
3
```

```
2  Normal, fama devido ao programa de tv. A sobre...    neutral
1
3                    im feeling a little less jaded    sadness
0
4  i have never shaken the feeling of ferocious p...       hate
6
```

```
df = df[['text','emotion_class']]
```

```
df.head()
```

```
                                                text  emotion_class
0  Yeah for coupons!   Found this place randomly ...              1
1  i still love to feel a gentle breeze and hear ...              3
2  Normal, fama devido ao programa de tv. A sobre...              1
3                    im feeling a little less jaded              0
4  i have never shaken the feeling of ferocious p...              6
```

Preprocess Text

```
df['new_text'] = df['text'].apply(lambda x: x.lower())
df['new_text'] = df['new_text'].apply(nfx.remove_multiple_spaces)
df['new_text'] = df['new_text'].apply(nfx.remove_punctuations)
df['new_text'] = df['new_text'].apply(nfx.remove_puncts)
df['new_text'] = df['new_text'].apply(nfx.remove_stopwords)
df['new_text'] = df['new_text'].apply(nfx.remove_emojis)
df['new_text'] = df['new_text'].apply(nfx.remove_special_characters)
df['new_text'] = df['new_text'].apply(nfx.remove_bad_quotes)
df['new_text'] = df['new_text'].apply(nfx.remove_non_ascii)
df['new_text'] = df['new_text'].apply(nfx.remove_accents)
df['new_text'] = df['new_text'].apply(nfx.remove_urls)
df['new_text'] = df['new_text'].apply(nfx.remove_html_tags)
df['new_text'] = df['new_text'].apply(nfx.remove_userhandles)
df['new_text'] = df['new_text'].apply(nfx.remove_hashtags)
df['new_text'] = df['new_text'].apply(nfx.remove_phone_numbers)
```

```
df.head()
```

```
                                                text  emotion_class  \
0  Yeah for coupons!   Found this place randomly ...              1
1  i still love to feel a gentle breeze and hear ...              3
2  Normal, fama devido ao programa de tv. A sobre...              1
3                    im feeling a little less jaded              0
4  i have never shaken the feeling of ferocious p...              6

                                            new_text
0  yeah coupons found place randomly like lot dif...
1  love feel gentle breeze hear peal soft wind ch...
2  normal fama devido ao programa de tv sobremesa...
3                          im feeling little jaded
4     shaken feeling ferocious protectiveness mother
```

```
df = df[['new_text','emotion_class']]

df.head()
```

```
                                            new_text  emotion_class
0  yeah coupons found place randomly like lot dif...              1
1  love feel gentle breeze hear peal soft wind ch...              3
2  normal fama devido ao programa de tv sobremesa...              1
3                          im feeling little jaded                0
4     shaken feeling ferocious protectiveness mother              6
```

Setup Tokenization And Lemmatization Parameter

```
# Lemmatization is slower than stemming but it is generally more
effective. It gives more context and meaning to words. It preserves
them
class LemmaTokenizer:
    def __init__(self):
        self.lemma = WordNetLemmatizer()
    def __call__(self, text):
        tokenized = word_tokenize(text)
        lemmatized=[]

        for token,tag in pos_tag(tokenized):
            pos=tag[0].lower()

            if pos not in ['a', 'r', 'n', 'v']:
                pos='n'

            lemmatized.append(self.lemma.lemmatize(token,pos))

        return lemmatized
```

Setup Folds With StratifiedKFold

```
folds = StratifiedKFold(n_splits = 10, shuffle = True, random_state =
1000) # since dataset is somewhat imbalanced (1 class)
```

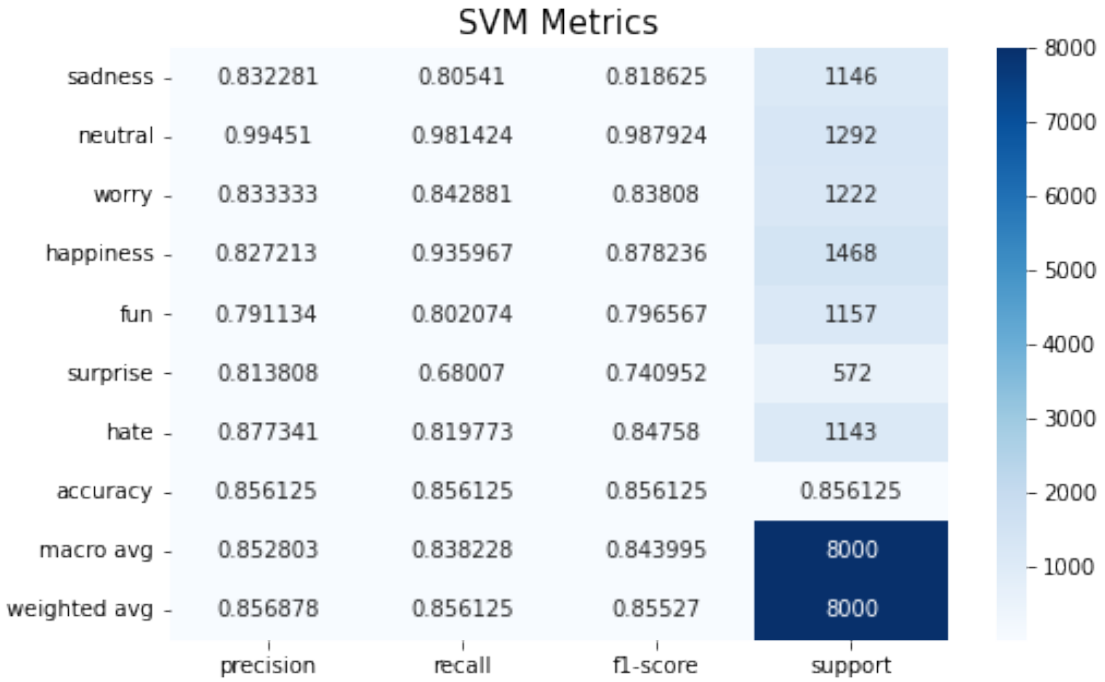
Base Models With Estimators And Transformers

```
target_names =
['sadness','neutral','worry','happiness','fun','surprise','hate']
```

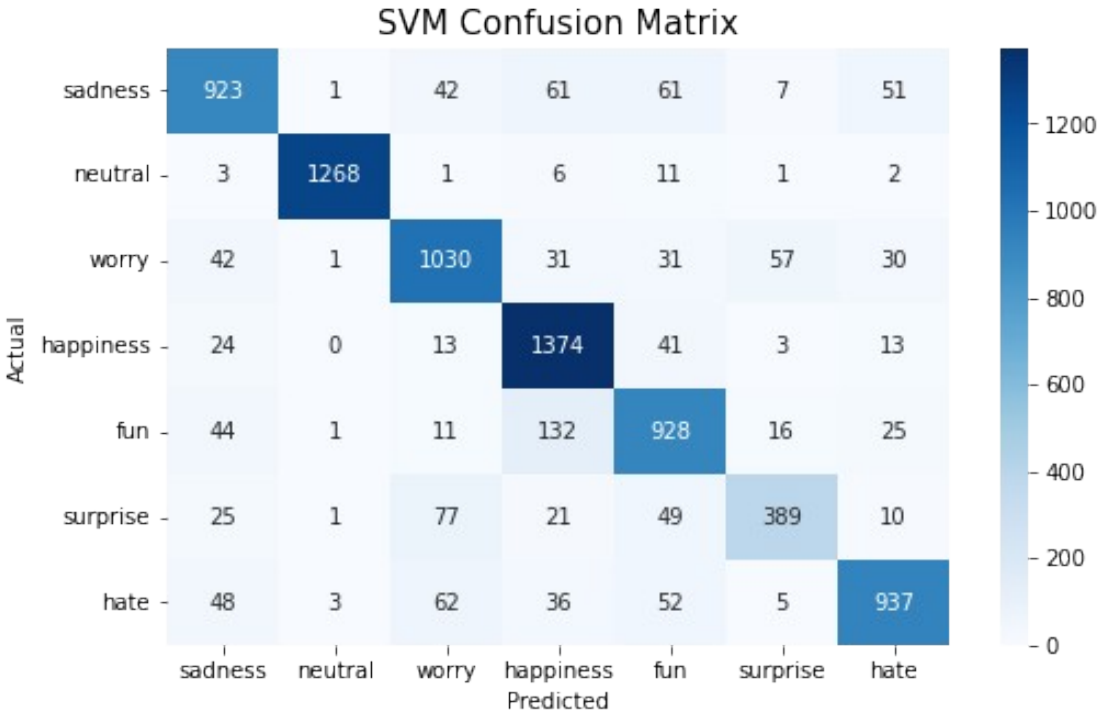
SVM

```
svm = Pipeline([
    ('vect', CountVectorizer(tokenizer=LemmaTokenizer())),
    ('tfidf', TfidfTransformer()),
    ('svm', SVC(decision_function_shape='ovr')),
])

svm_prediction = cross_val_predict(svm, df['new_text'],
df['emotion_class'], cv = folds)
svm_score = cross_val_score(svm, df['new_text'], df['emotion_class'],
```

```
cv = folds)

svm_report = classification_report(df['emotion_class'],
svm_prediction, target_names=target_names, output_dict=True)

plt.figure(figsize=(8, 5))
plt.title('SVM Metrics', fontsize=15)
sns.heatmap(pd.DataFrame(svm_report).T, annot=True, cmap='Blues',
fmt='g')

<AxesSubplot:title={'center':'SVM Metrics'}>
```

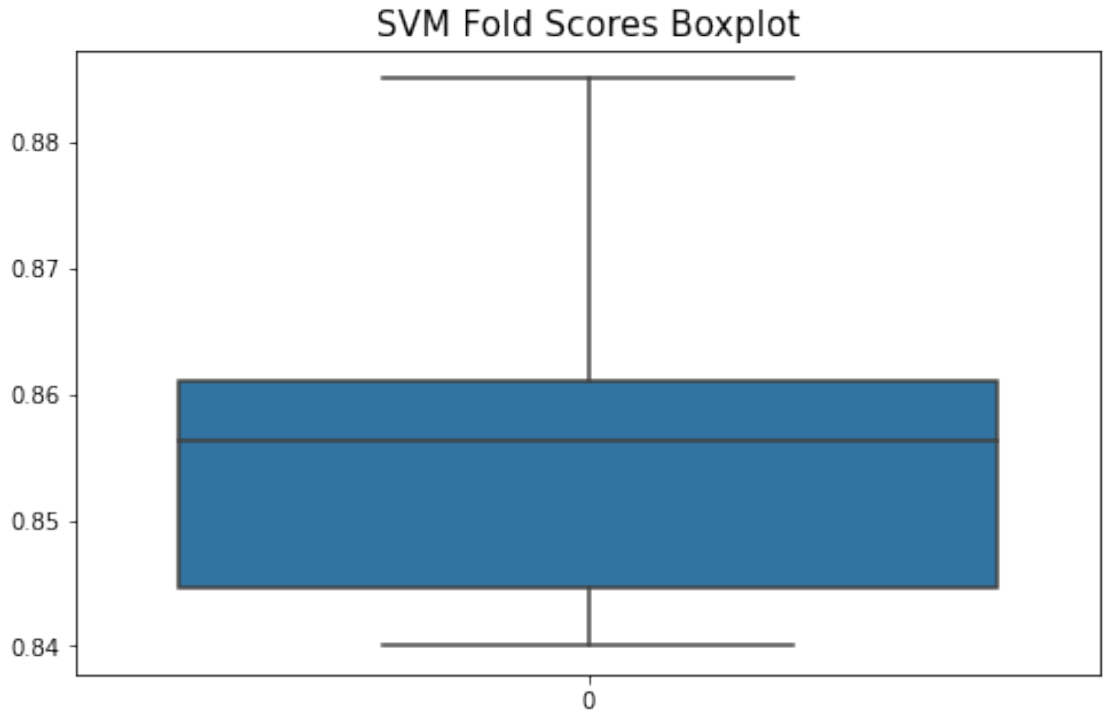



```
svm_matrix = confusion_matrix(df['emotion_class'], svm_prediction)
plt.figure(figsize=(8, 5))
sns.heatmap(pd.DataFrame(svm_matrix, target_names, target_names),
annot=True, cmap='Blues', fmt='g')
plt.title('SVM Confusion Matrix', fontsize=15)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.show()
```




```
plt.figure(figsize=(8, 5))
plt.title('SVM Fold Scores Boxplot', fontsize=15)
sns.boxplot(data=svm_score)
```

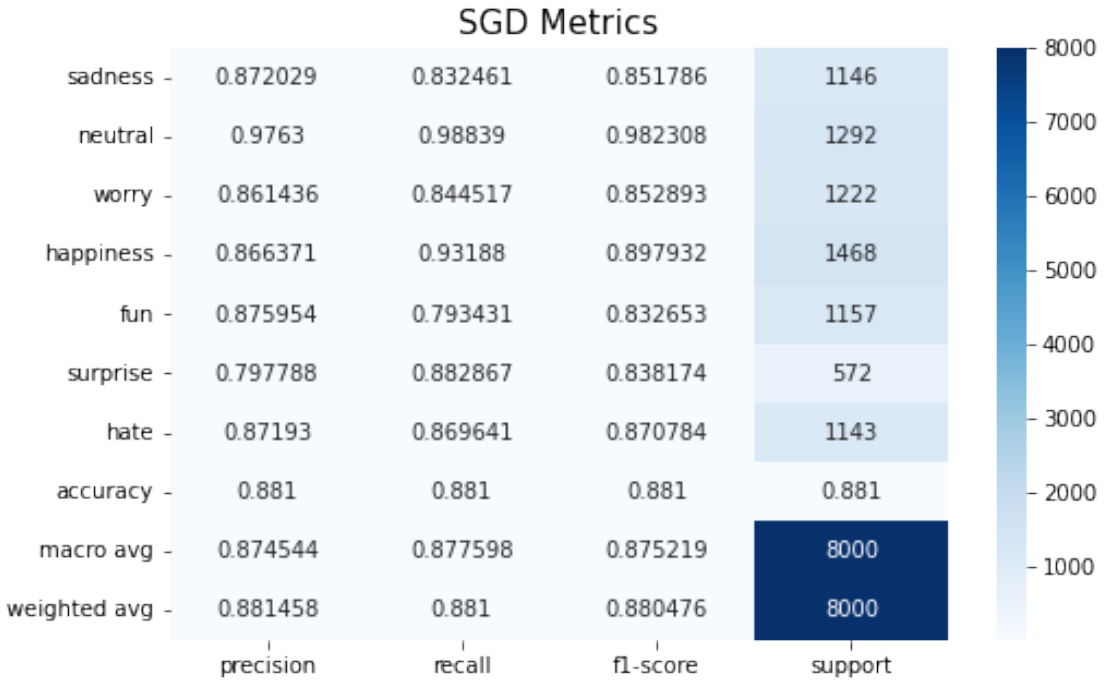
```
<AxesSubplot:title={'center':'SVM Fold Scores Boxplot'}>
```



SGD

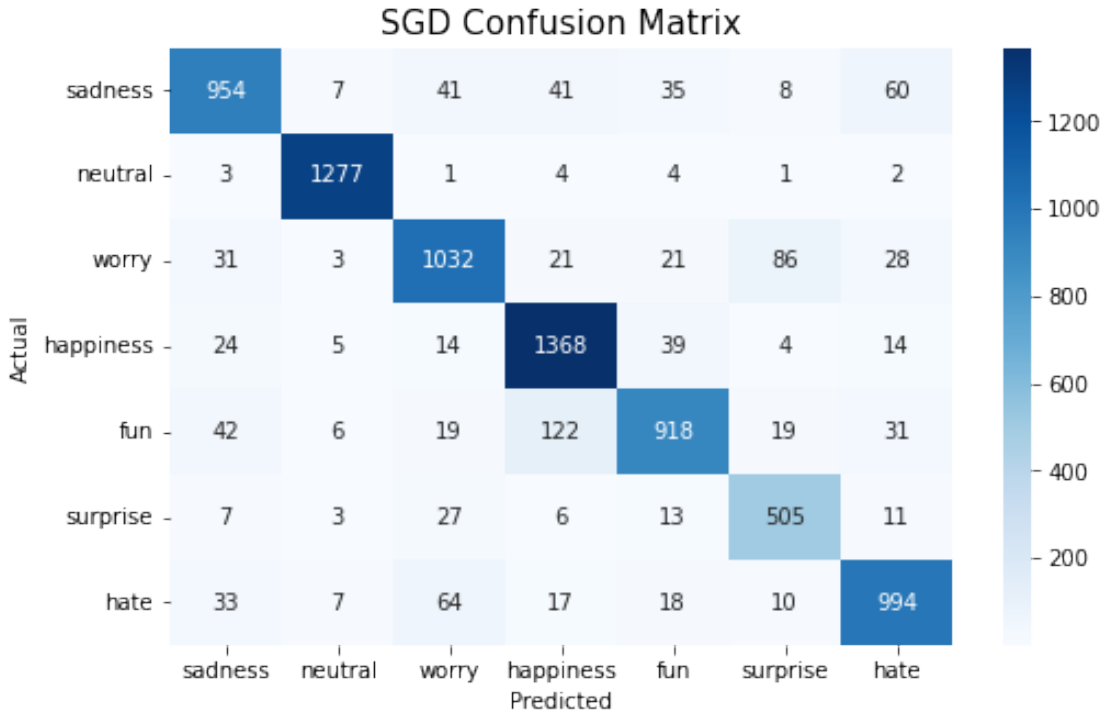
```
sgd = Pipeline([
    ('vect', CountVectorizer(tokenizer=LemmaTokenizer())),
    ('tfidf', TfidfTransformer()),
    ('sgd', OneVsRestClassifier(SGDClassifier())),
])

sgd_prediction = cross_val_predict(sgd, df['new_text'],
df['emotion_class'], cv = folds)
sgd_score = cross_val_score(sgd, df['new_text'], df['emotion_class'],
cv = folds)

sgd_report = classification_report(df['emotion_class'],
sgd_prediction, target_names=target_names, output_dict=True)

plt.figure(figsize=(8, 5))
plt.title('SGD Metrics', fontsize=15)
sns.heatmap(pd.DataFrame(sgd_report).T, annot=True, cmap='Blues',
fmt='g')
```

```
<AxesSubplot:title={'center':'SGD Metrics'}>
```



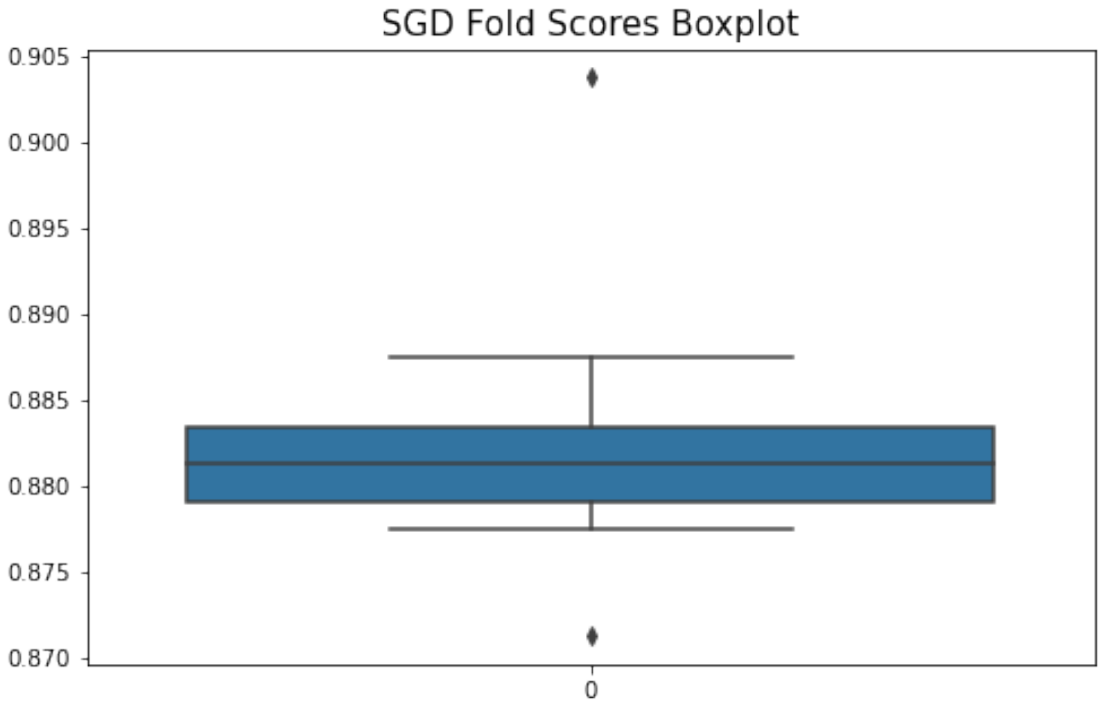

```
sgd_matrix = confusion_matrix(df['emotion_class'], sgd_prediction)
plt.figure(figsize=(8, 5))
sns.heatmap(pd.DataFrame(sgd_matrix, target_names, target_names),
annot=True, cmap='Blues', fmt='g')
plt.title('SGD Confusion Matrix', fontsize=15)
plt.ylabel('Actual')
```

```
plt.xlabel('Predicted')
plt.show()
```



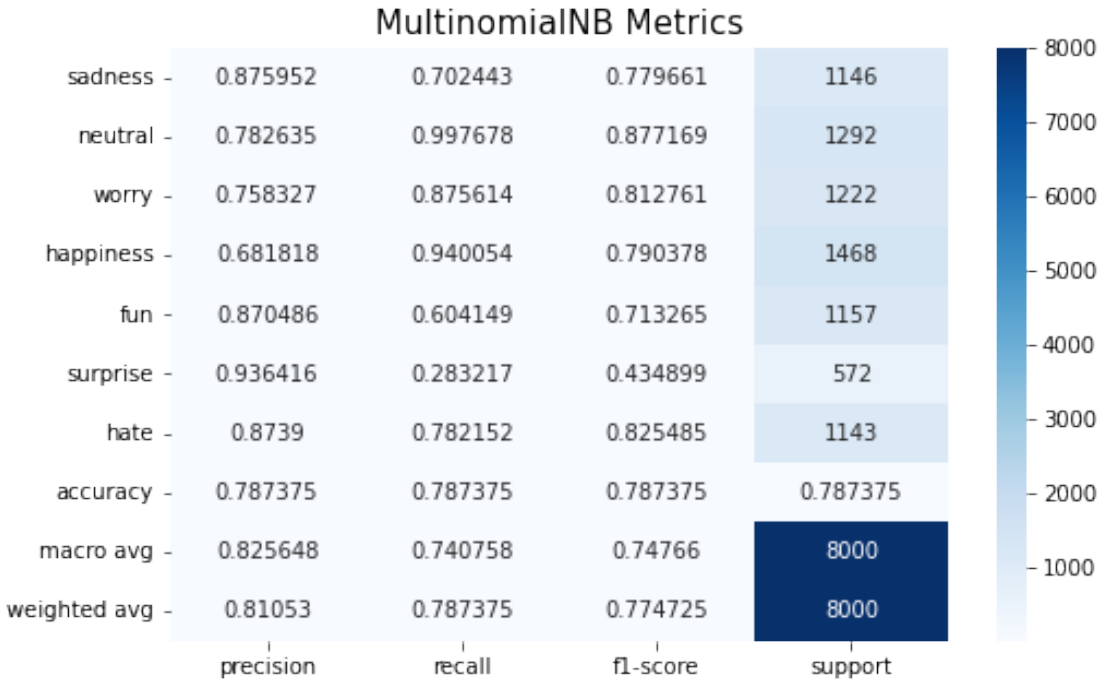

```
plt.figure(figsize=(8, 5))
plt.title('SGD Fold Scores Boxplot', fontsize=15)
sns.boxplot(data=sgd_score)
```

```
<AxesSubplot:title={'center':'SGD Fold Scores Boxplot'}>
```

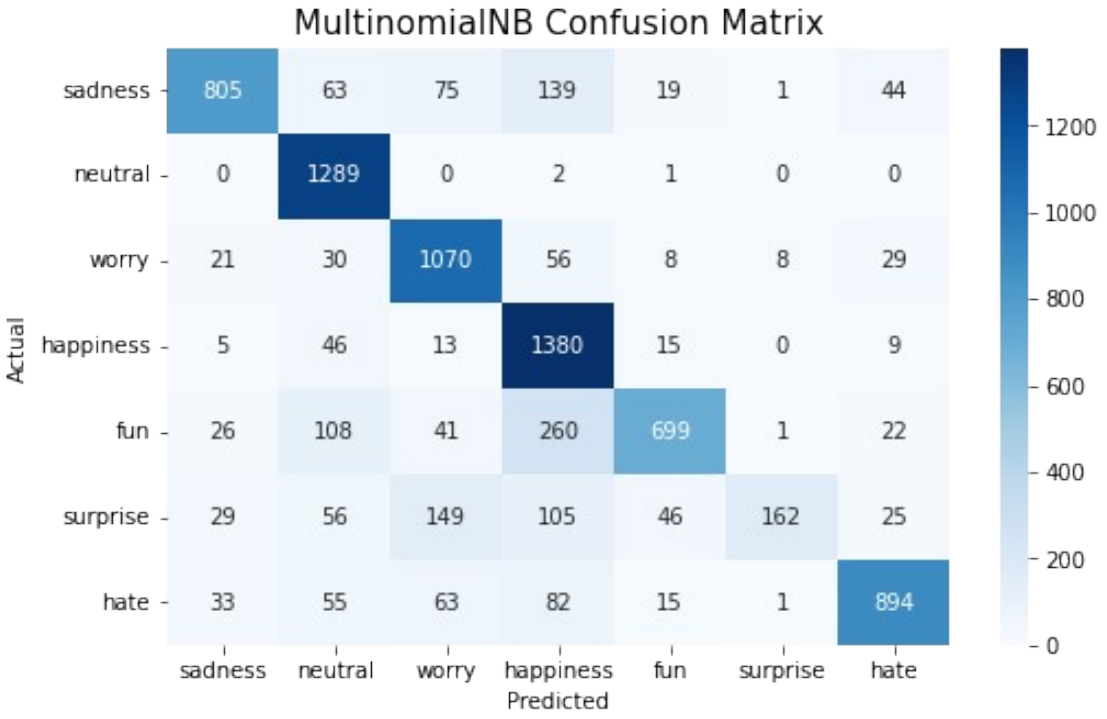


Naive Bayes (Multinomial)

```
bayes = Pipeline([
    ('vect', CountVectorizer(tokenizer=LemmaTokenizer())),
    ('tfidf', TfidfTransformer()),
    ('bayes', OneVsRestClassifier(MultinomialNB())),
])

bayes_prediction = cross_val_predict(bayes, df['new_text'],
df['emotion_class'], cv = folds)
bayes_score = cross_val_score(bayes, df['new_text'],
df['emotion_class'], cv = folds)

bayes_report = classification_report(df['emotion_class'],
bayes_prediction,target_names=target_names, output_dict=True)

plt.figure(figsize=(8, 5))
plt.title('MultinomialNB Metrics', fontsize=15)
sns.heatmap(pd.DataFrame(bayes_report).T, annot=True, cmap='Blues',
fmt='g')

<AxesSubplot:title={'center':'MultinomialNB Metrics'}>
```

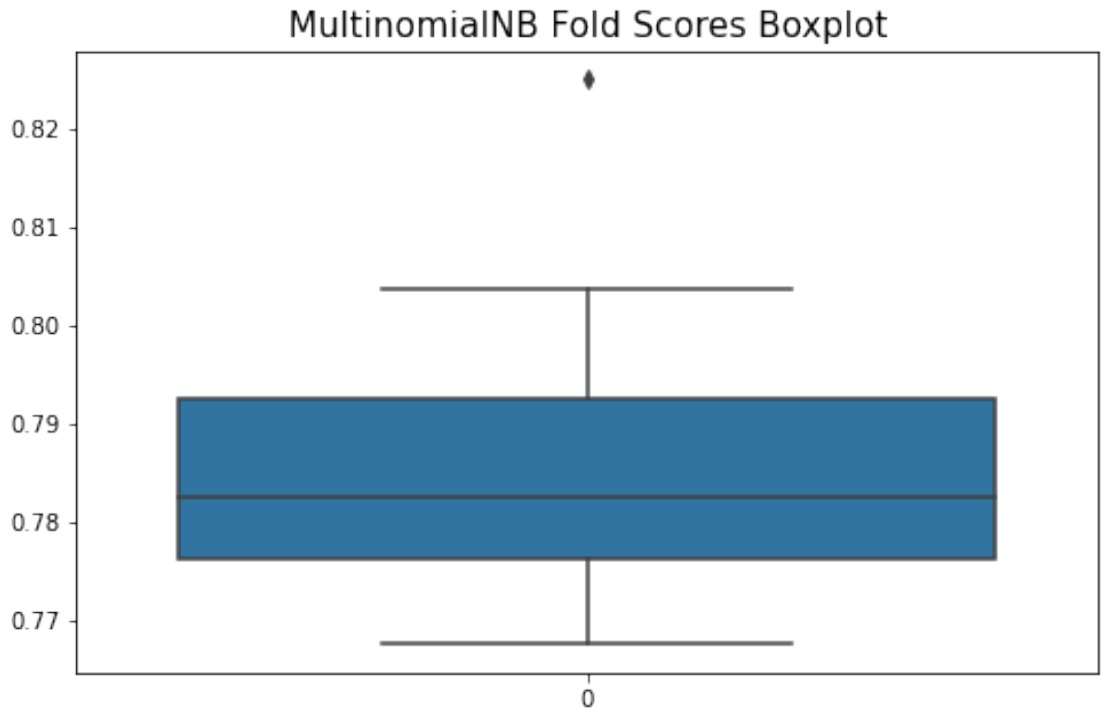



```
bayes_matrix = confusion_matrix(df['emotion_class'], bayes_prediction)
plt.figure(figsize=(8, 5))
sns.heatmap(pd.DataFrame(bayes_matrix, target_names, target_names),
annot=True, cmap='Blues', fmt='g')
plt.title('MultinomialNB Confusion Matrix', fontsize=15)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.show()
```




```
plt.figure(figsize=(8, 5))
plt.title('MultinomialNB Fold Scores Boxplot', fontsize=15)
sns.boxplot(data=bayes_score)
```

```
<AxesSubplot:title={'center':'MultinomialNB Fold Scores Boxplot'}>
```



Parameter Tuning (GridSearchCV)

Train Test Split

```
x_train, x_test, y_train, y_test =
train_test_split(df['new_text'],df['emotion_class'],shuffle=True,strat
ify=df['emotion_class'],test_size=0.2,random_state=20)
```

Pipelines

```
pipe_svm = Pipeline([('vect',
CountVectorizer(tokenizer=LemmaTokenizer())),('transformer',
TfidfTransformer()),('svm', SVC(decision_function_shape='ovr'))])
pipe_sgd = Pipeline([('vect',
CountVectorizer(tokenizer=LemmaTokenizer())),('transformer',
TfidfTransformer()),('sgd', OneVsRestClassifier(SGDClassifier()))])
pipe_bayes = Pipeline([('vect',
CountVectorizer(tokenizer=LemmaTokenizer())),('transformer',
TfidfTransformer()),('mnb', OneVsRestClassifier(MultinomialNB()))])
```

Parameters

```
# Support Vector Machine parameters to test
svm_params = {'svm__C': [0.1, 1, 10, 100, 1000],
              'svm__gamma': [1, 0.1, 0.01, 0.001, 0.0001],
              'svm__kernel': ('linear','rbf'),
              'vect__ngram_range': [(1, 1), (1, 2)]
             }

# SGD Classifier parameters to test
sgd_params = {
    "sgd__loss" : ["hinge", "log_loss", "squared_hinge",
"modified_huber"],
    "sgd__alpha" : [0.0001, 0.001, 0.01, 0.1],
    "sgd__penalty" : ["l2", "l1", "none"],
    "sgd__learning_rate" :
["constant","optimal","invscaling","adaptive"],
    "sgd__class_weight": [None,'balanced'],
    'vect__ngram_range': [(1, 1), (1, 2)],
             }

# Bayes Classifier parameters to test
bayes_params = {
    "mnb__alpha" : [0.01, 0.1, 0.5, 1.0, 10.0],
    "mnb__fit_prior" : (True,False),
    "vect__ngram_range":[(1,1),(1,2),(1,6)]
              }
```

Process

```
# Setting up grids
grid_svm = GridSearchCV(pipe_svm, parameters, refit = True, verbose =
3)
grid_sgd = GridSearchCV(pipe_sgd, parameters, refit = True, verbose =
```

```
3)
grid_bayes = GridSearchCV(pipe_bayes, parameters, refit = True,
verbose = 3)

# Fitting the grid
grid.fit(x_train, y_train)
grid.fit(x_train, y_train)
grid.fit(x_train, y_train)
```

Results

```
# Support Vector Machine
{'svc__C': 1, 'svc__gamma': 1, 'svc__kernel': 'linear',
'vect__ngram_range': (1, 2)}

{'svc__C': 1,
 'svc__gamma': 1,
 'svc__kernel': 'linear',
 'vect__ngram_range': (1, 2)}

# SGD Classifier
{'sgd__loss': 'hinge', 'sgd__alpha': '0.0001', 'sgd__penalty': 'l1',
'sgd__learning_rate': 'optimal', 'sgd__class_weight': None,
'vect__ngram_range': (1,2)}

{'sgd__loss': 'hinge',
 'sgd__alpha': '0.0001',
 'sgd__penalty': 'l1',
 'sgd__learning_rate': 'optimal',
 'sgd__class_weight': None,
 'vect__ngram_range': (1, 2)}

# Bayes Classifier
{'mb__alpha': 0.1, 'mb__fit_prior': False, 'vect__ngram_range': (1,6)}

{'mb__alpha': 0.1, 'mb__fit_prior': False, 'vect__ngram_range': (1,
6)}
```

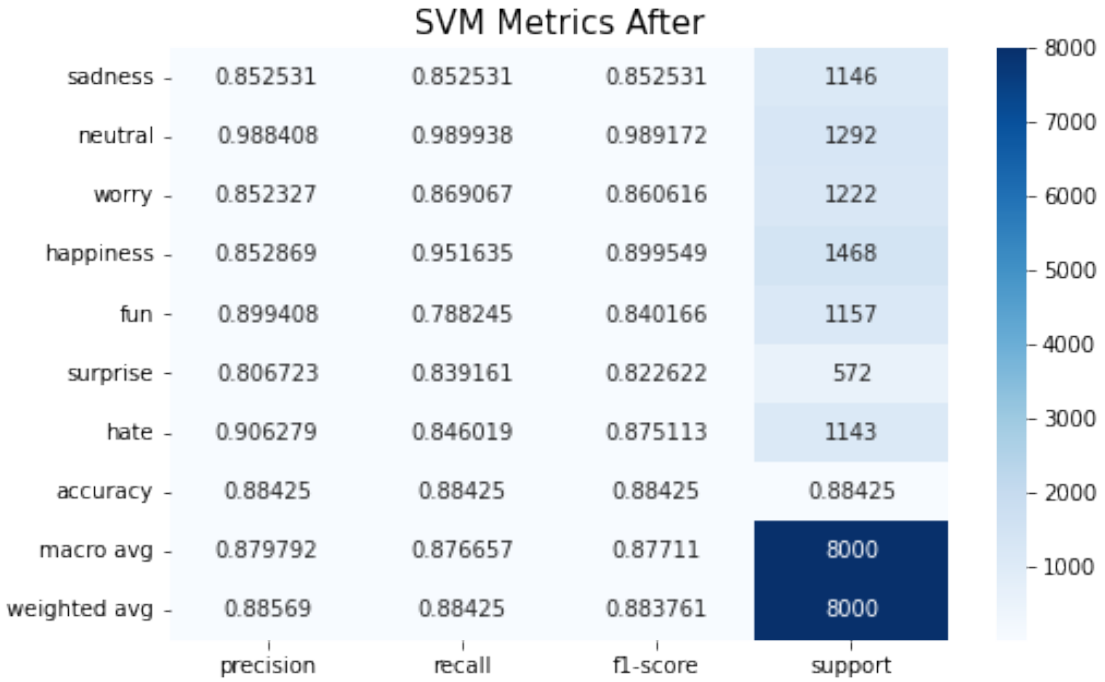
After Tuning

SVM

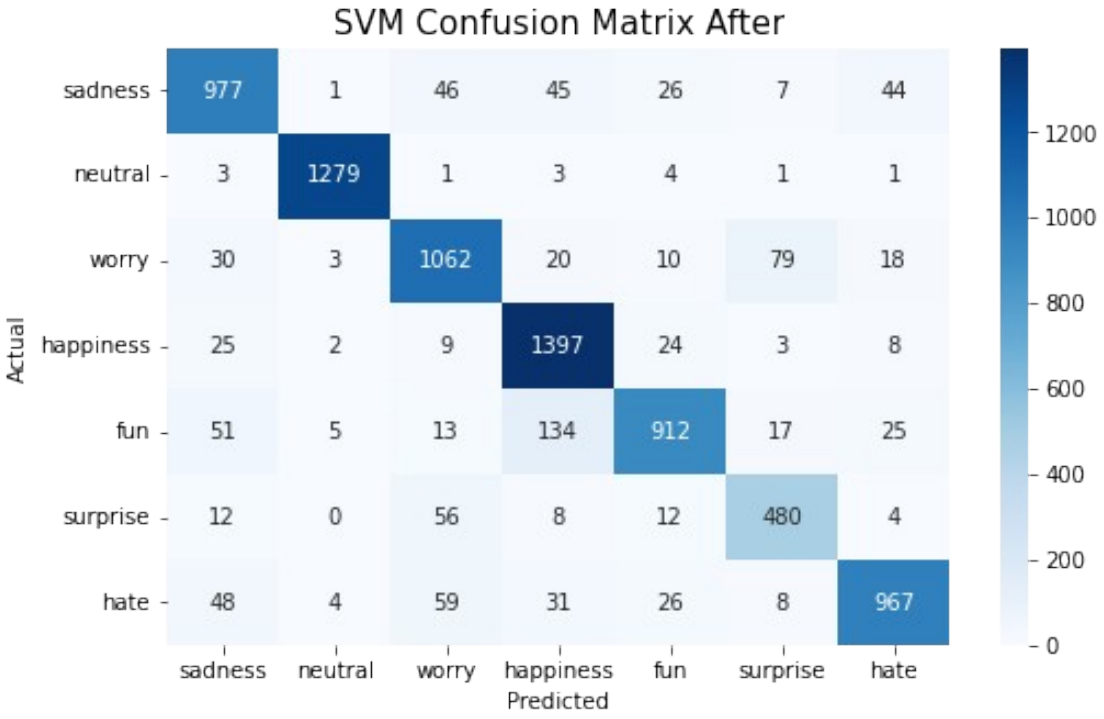
```
svm_after = Pipeline([
    ('vect',
CountVectorizer(tokenizer=LemmaTokenizer(),ngram_range=(1,2))),
    ('tfidf', TfidfTransformer()),
    ('svm',
SVC(C=1,gamma=1,kernel='linear',decision_function_shape='ovr')),
])

svm_prediction_after = cross_val_predict(svm_after, df['new_text'],
df['emotion_class'], cv = folds)
svm_score_after = cross_val_score(svm_after, df['new_text'],
```

```
df['emotion_class'], cv = folds)

svm_report_after = classification_report(df['emotion_class'],
svm_prediction_after, target_names=target_names, output_dict=True)

plt.figure(figsize=(8, 5))
plt.title('SVM Metrics After', fontsize=15)
sns.heatmap(pd.DataFrame(svm_report_after).T, annot=True,
cmap='Blues', fmt='g')
```

```
<AxesSubplot:title={'center':'SVM Metrics After'}>
```

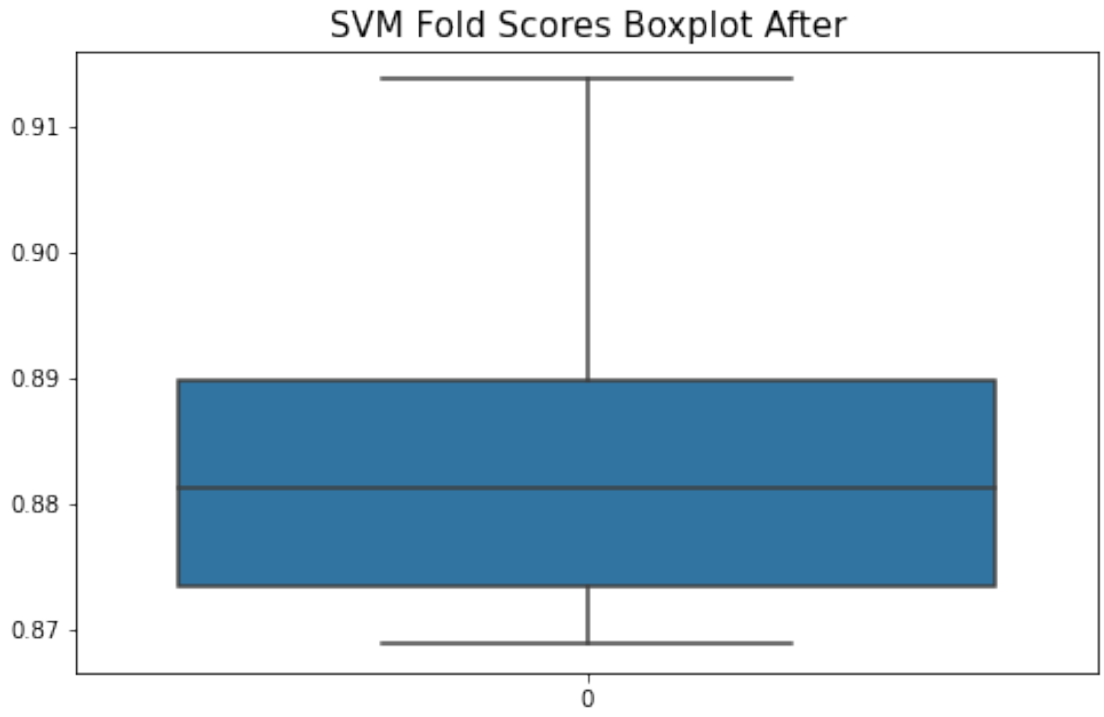



```
svm_matrix_after = confusion_matrix(df['emotion_class'],
svm_prediction_after)
plt.figure(figsize=(8, 5))
sns.heatmap(pd.DataFrame(svm_matrix_after, target_names,
target_names), annot=True, cmap='Blues', fmt='g')
plt.title('SVM Confusion Matrix After', fontsize=15)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.show()
```




```
plt.figure(figsize=(8, 5))
plt.title('SVM Fold Scores Boxplot After', fontsize=15)
sns.boxplot(data=svm_score_after)
```

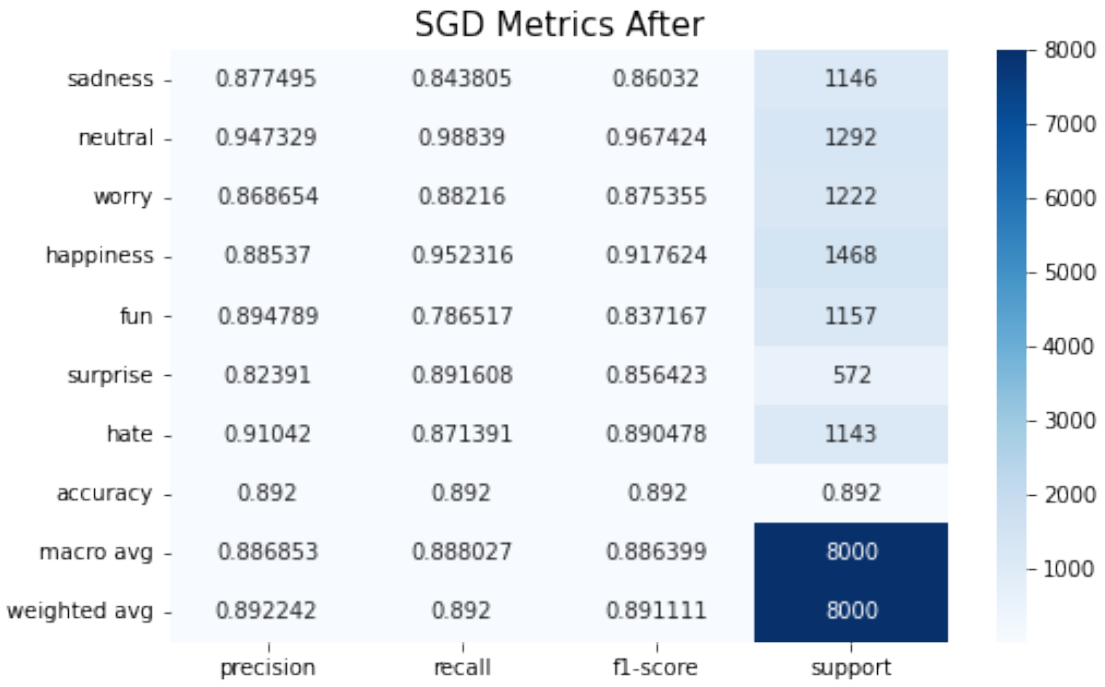
```
<AxesSubplot:title={'center':'SVM Fold Scores Boxplot After'}>
```



SGD

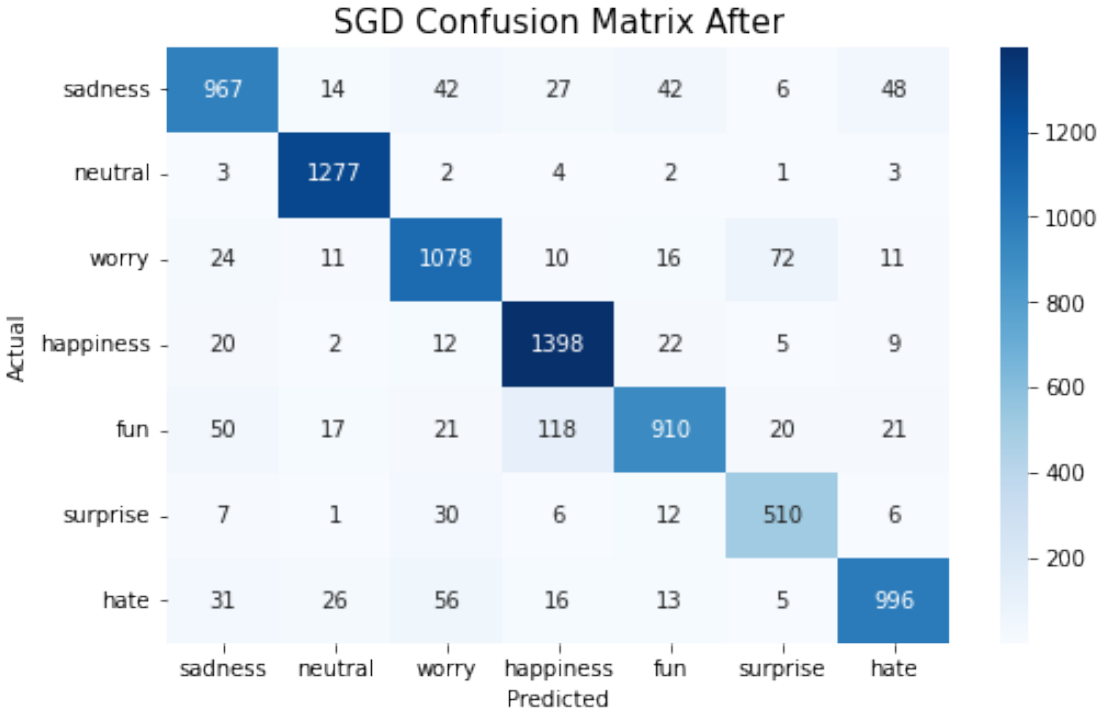
```
sgd_after = Pipeline([
    ('vect',
CountVectorizer(tokenizer=LemmaTokenizer(),ngram_range=(1,2))),
    ('tfidf', TfidfTransformer()),
    ('sgd',
OneVsRestClassifier(SGDClassifier(loss='hinge',alpha=0.0001,penalty='l
1',learning_rate='optimal',class_weight=None))),
])

sgd_prediction_after = cross_val_predict(sgd_after, df['new_text'],
df['emotion_class'], cv = folds)
sgd_score_after = cross_val_score(sgd_after, df['new_text'],
df['emotion_class'], cv = folds)

sgd_report_after = classification_report(df['emotion_class'],
sgd_prediction_after, target_names=target_names, output_dict=True)

plt.figure(figsize=(8, 5))
plt.title('SGD Metrics After', fontsize=15)
sns.heatmap(pd.DataFrame(sgd_report_after).T, annot=True,
cmap='Blues', fmt='g')
```

```
<AxesSubplot:title={'center':'SGD Metrics After'}>
```



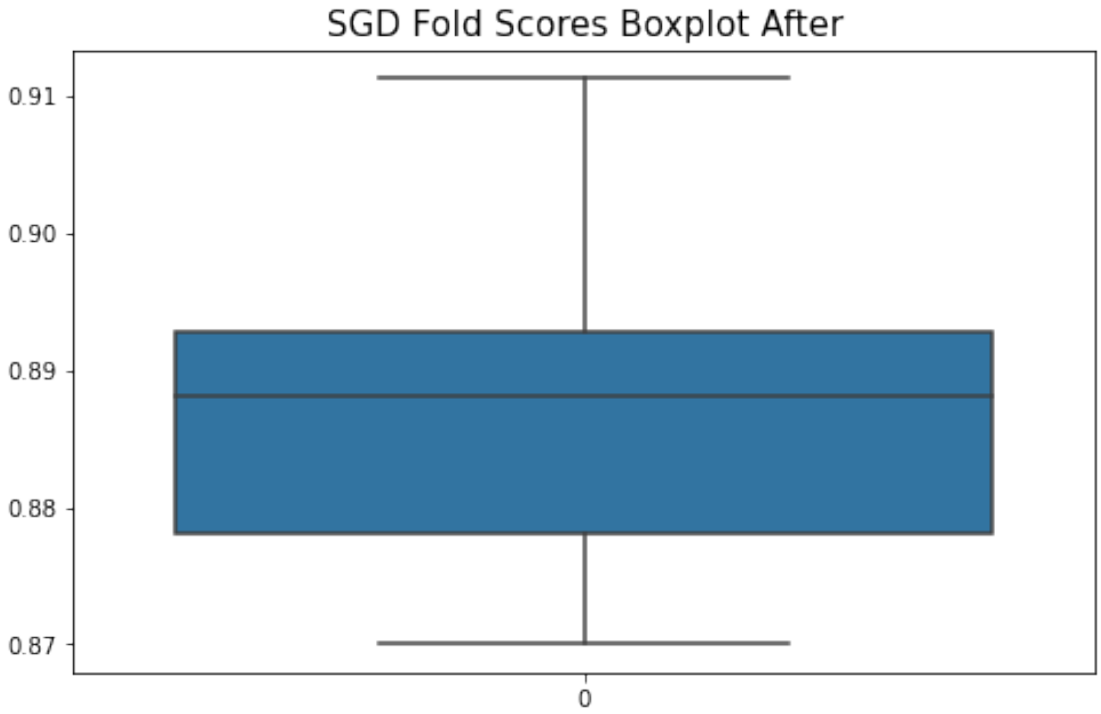

```
sgd_matrix_after = confusion_matrix(df['emotion_class'],
sgd_prediction_after)
plt.figure(figsize=(8, 5))
sns.heatmap(pd.DataFrame(sgd_matrix_after, target_names,
```

```
target_names), annot=True, cmap='Blues', fmt='g')
plt.title('SGD Confusion Matrix After', fontsize=15)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.show()
```



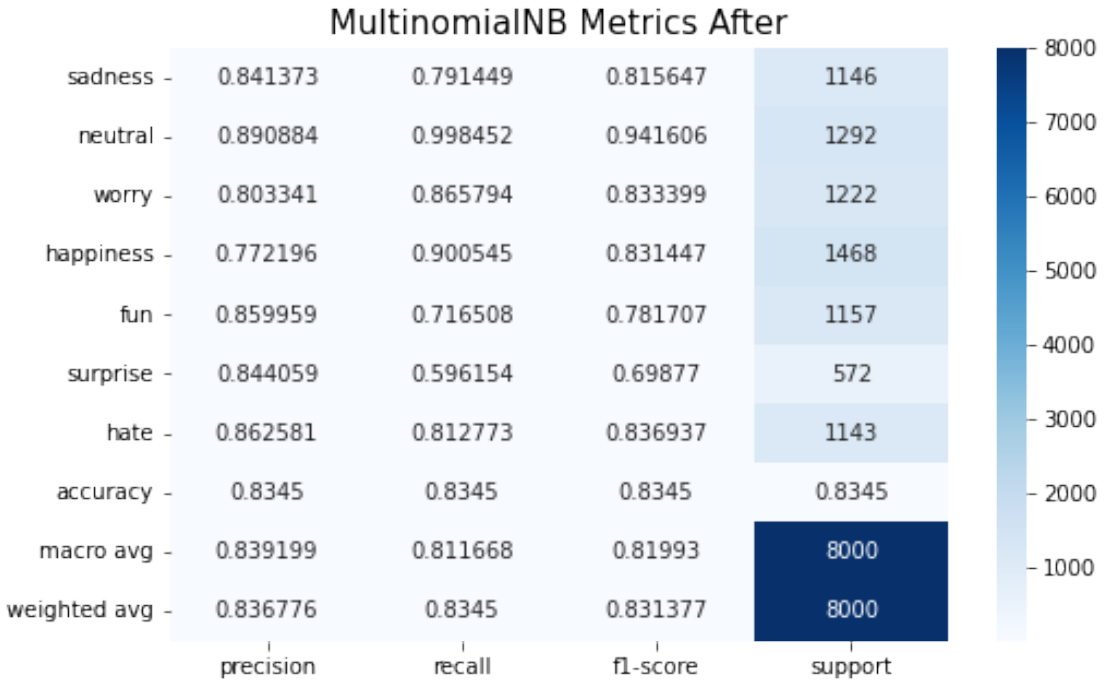

```
plt.figure(figsize=(8, 5))
plt.title('SGD Fold Scores Boxplot After', fontsize=15)
sns.boxplot(data=sgd_score_after)
```

```
<AxesSubplot:title={'center':'SGD Fold Scores Boxplot After'}>
```

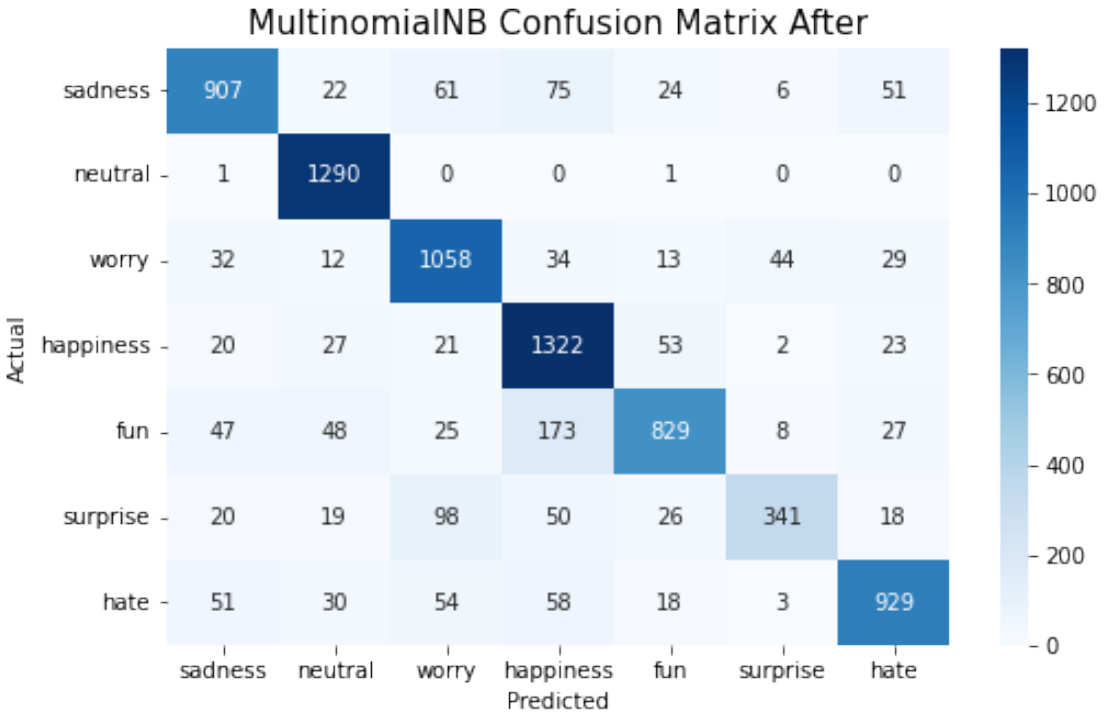


Naive Bayes (Multinomial)

```
mnb_after = Pipeline([
    ('vect',
CountVectorizer(tokenizer=LemmaTokenizer(),ngram_range=(1,6))),
    ('tfidf', TfidfTransformer()),
    ('mnb',
OneVsRestClassifier(MultinomialNB(alpha=0.1,fit_prior=False))),
])

mnb_prediction_after = cross_val_predict(mnb_after, df['new_text'],
df['emotion_class'], cv = folds)
mnb_score_after = cross_val_score(mnb_after, df['new_text'],
df['emotion_class'], cv = folds)

mnb_report_after = classification_report(df['emotion_class'],
mnb_prediction_after, target_names=target_names, output_dict=True)

plt.figure(figsize=(8, 5))
plt.title('MultinomialNB Metrics After', fontsize=15)
sns.heatmap(pd.DataFrame(mnb_report_after).T, annot=True,
cmap='Blues', fmt='g')

<AxesSubplot:title={'center':'MultinomialNB Metrics After'}>
```

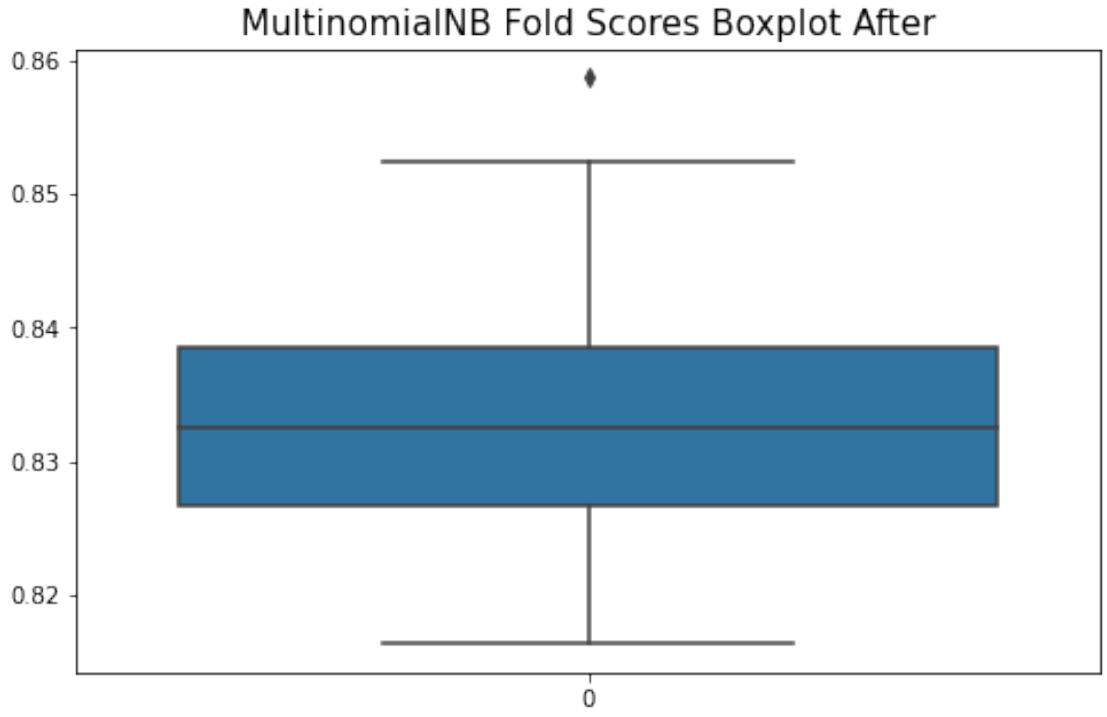



```
mnb_matrix_after = confusion_matrix(df['emotion_class'],
mnb_prediction_after)
plt.figure(figsize=(8, 5))
sns.heatmap(pd.DataFrame(mnb_matrix_after, target_names,
target_names), annot=True, cmap='Blues', fmt='g')
plt.title('MultinomialNB Confusion Matrix After', fontsize=15)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.show()
```




```
plt.figure(figsize=(8, 5))
plt.title('MultinomialNB Fold Scores Boxplot After', fontsize=15)
sns.boxplot(data=mnb_score_after)
```

```
<AxesSubplot:title={'center':'MultinomialNB Fold Scores Boxplot
After'}>
```



Winner

And the winner is...SGDClassifier

Stacking

```
estimators =
[('svc',SVC(C=1,gamma=1,kernel='linear',decision_function_shape='ovr')
)]

final_estimator =
OneVsRestClassifier(SGDClassifier(loss='hinge',alpha=0.0001,penalty='l
1',learning_rate='optimal',class_weight=None))

stack = StackingClassifier(estimators=estimators,
final_estimator=final_estimator,cv=10)

stacking_pipe = Pipeline([('vect',
CountVectorizer(tokenizer=LemmaTokenizer(),ngram_range=(1,2))),
('tfidf', TfidfTransformer()),('stack', stack)])

stacking_pipe.fit(x_train, y_train)

Pipeline(steps=[('vect',
                 CountVectorizer(ngram_range=(1, 2),
                                 tokenizer=<__main__.LemmaTokenizer
object at 0x00000206A7911708>)),
                ('tfidf', TfidfTransformer()),
                ('stack',
                 StackingClassifier(cv=10,
                                    estimators=[('svc',
                                                 SVC(C=1, gamma=1,

kernel='linear'))],

final_estimator=OneVsRestClassifier(estimator=SGDClassifier(penalty='l
1')))))])

stacking_pipe.score(x_test,y_test)

0.88875

stacking_pipe.score(x_train,y_train)

0.99
```

Results

SGDClassifier alone still wins