Hyperparameters Support Vector Machine Classifier

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In [1]:
```python
import numpy as np
import matplotlib.pyplot as plt

from sklearn.svm import LinearSVC, SVC
from sklearn.metrics import confusion_matrix, classification_report, roc_curve

import pickle
X_train_smt = pickle.load(open("saved_feats/ShuffleSplit_X_train_smt", "rb"))
X_test = pickle.load(open("saved_feats/ShuffleSplit_X_test", "rb"))
y_train_smt = pickle.load(open("saved_feats/ShuffleSplit_y_train_smt", "rb"))
y_test = pickle.load(open("saved_feats/ShuffleSplit_y_test", "rb"))

# FORMATO DE PLOTS
plt.style.use('bmh')
```

Parámetros por defecto

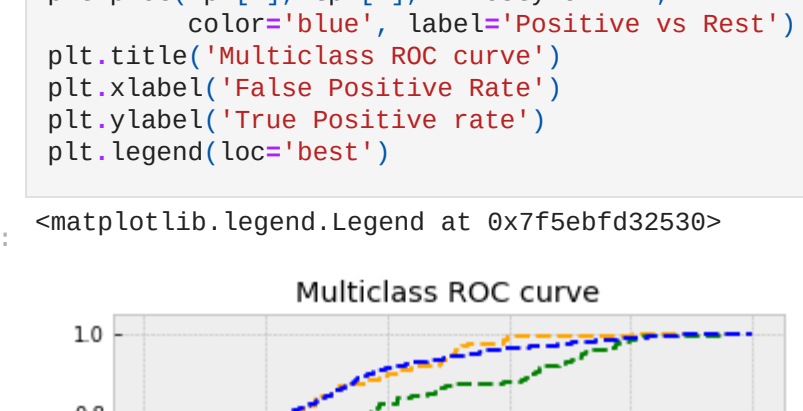
In [2]:
```python
clf_svc = LinearSVC(penalty='l2', loss='squared_hinge', dual=True, tol=0.0001, C=1.0, multi_class='ovr',
                    fit_intercept=True, intercept_scaling=1, class_weight=None, verbose=0, random_state=None,
clf_svc.fit(X_train_smt, y_train_smt)
pred_svc = clf_svc.predict(X_test)
estim_prob_svc = np.array(clf_svc.decision_function(
    X_test))  # decision is a voting function
pred_prob_svc = np.exp(estim_prob_svc)/np.sum(np.exp(estim_prob_svc),
                                              axis=1, keepdims=True)  # softmax after the voting
```

In [3]:
```python
print('Predicted classes:', clf_svc.classes_)
print('Average accuracy :', np.mean(pred_svc == y_test)*100)
print('Train accuracy :', (clf_svc.score(
    X_train_smt, y_train_smt))*100)
print('Test accuracy :', (clf_svc.score(
    X_test, y_test))*100)

print('\n CONFUSION MATRIX')
print(confusion_matrix(y_test, pred_svc))
print('\n CLASSIFICATION REPORT')
print(classification_report(y_test, pred_svc))
```

```
Predicted classes: ['Negative' 'Neutral' 'Positive']
Average accuracy : 88.05805621899687
Train accuracy : 97.42591497470268
Test accuracy : 88.05805621899687

 CONFUSION MATRIX
[[  52   27   40]
 [  37   91  122]
 [  78  346 4650]]

 CLASSIFICATION REPORT
              precision    recall  f1-score   support

    Negative       0.31      0.44      0.36       119
     Neutral       0.20      0.36      0.25       250
    Positive       0.97      0.92      0.94      5074

    accuracy                           0.88      5443
   macro avg       0.49      0.57      0.52      5443
weighted avg       0.92      0.88      0.90      5443
```

In [4]:
```python
fpr = {}
tpr = {}
thresh = {}

fpr[0], tpr[0], thresh[0] = roc_curve(
    y_test, pred_prob_svc[:, 0], pos_label='Negative')
fpr[1], tpr[1], thresh[1] = roc_curve(
    y_test, pred_prob_svc[:, 1], pos_label='Neutral')
fpr[2], tpr[2], thresh[2] = roc_curve(
    y_test, pred_prob_svc[:, 2], pos_label='Positive')

# plotting
plt.plot(fpr[0], tpr[0], linestyle='--',
         color='orange', label='Negative vs Rest')
plt.plot(fpr[1], tpr[1], linestyle='--',
         color='green', label='Neutral vs Rest')
plt.plot(fpr[2], tpr[2], linestyle='--',
         color='blue', label='Positive vs Rest')
plt.title('Multiclass ROC curve')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive rate')
plt.legend(loc='best')
```

Out[4]: `<matplotlib.legend.Legend at 0x7f5ebfd32530>`



Loss=hinge

In [5]:
```python
clf_svc_2 = LinearSVC(penalty='l2', loss='hinge', dual=True, tol=0.0001, C=1.0, multi_class='ovr',
                      fit_intercept=True, intercept_scaling=1, class_weight=None, verbose=0, random_state=None
clf_svc_2.fit(X_train_smt, y_train_smt)
pred_svc_2 = clf_svc_2.predict(X_test)
estim_prob_svc_2 = np.array(clf_svc_2.decision_function(
    X_test))  # decision is a voting function
pred_prob_svc_2 = np.exp(estim_prob_svc_2)/np.sum(np.exp(estim_prob_svc_2),
                                                  axis=1, keepdims=True)  # softmax after the voting
```

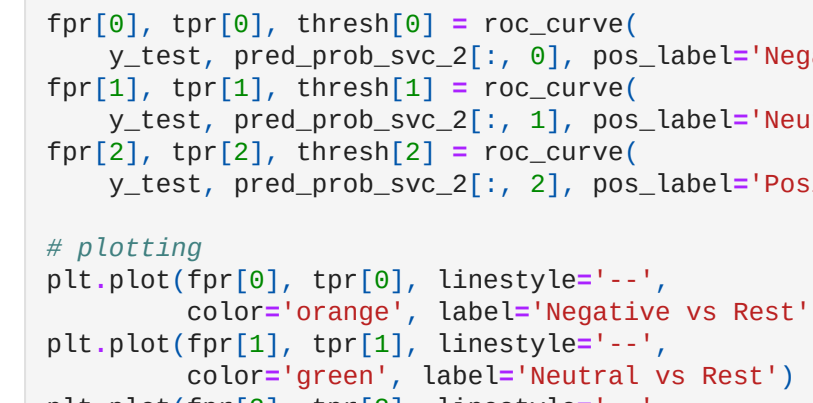
```
/usr/local/lib/python3.10/dist-packages/sklearn/svm/_base.py:1225: ConvergenceWarning: Liblinear failed to con
verge, increase the number of iterations.
  warnings.warn(
```

In [6]:
```python
print('Predicted classes:', clf_svc_2.classes_)
print('Average accuracy :', np.mean(pred_svc_2 == y_test)*100)
print('Train accuracy :', (clf_svc_2.score(
    X_train_smt, y_train_smt))*100)
print('Test accuracy :', (clf_svc_2.score(
    X_test, y_test))*100)

print('\n CONFUSION MATRIX')
print(confusion_matrix(y_test, pred_svc_2))
print('\n CLASSIFICATION REPORT')
print(classification_report(y_test, pred_svc_2))
```

```
Predicted classes: ['Negative' 'Neutral' 'Positive']
Average accuracy : 87.34153959213668
Train accuracy : 96.29082068467048
Test accuracy : 87.34153959213668

 CONFUSION MATRIX
[[  53   31   35]
 [  39  102  109]
 [  73  402 4599]]

 CLASSIFICATION REPORT
              precision    recall  f1-score   support

    Negative       0.32      0.45      0.37       119
     Neutral       0.19      0.41      0.26       250
    Positive       0.97      0.91      0.94      5074

    accuracy                           0.87      5443
   macro avg       0.49      0.59      0.52      5443
weighted avg       0.92      0.87      0.89      5443
```

In [7]:
```python
fpr = {}
tpr = {}
thresh = {}

fpr[0], tpr[0], thresh[0] = roc_curve(
    y_test, pred_prob_svc_2[:, 0], pos_label='Negative')
fpr[1], tpr[1], thresh[1] = roc_curve(
    y_test, pred_prob_svc_2[:, 1], pos_label='Neutral')
fpr[2], tpr[2], thresh[2] = roc_curve(
    y_test, pred_prob_svc_2[:, 2], pos_label='Positive')

# plotting
plt.plot(fpr[0], tpr[0], linestyle='--',
         color='orange', label='Negative vs Rest')
plt.plot(fpr[1], tpr[1], linestyle='--',
         color='green', label='Neutral vs Rest')
plt.plot(fpr[2], tpr[2], linestyle='--',
         color='blue', label='Positive vs Rest')
plt.title('Multiclass ROC curve')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive rate')
plt.legend(loc='best')
```

Out[7]: `<matplotlib.legend.Legend at 0x7f5ebda9e440>`



Dual = False, fit_intercept=False

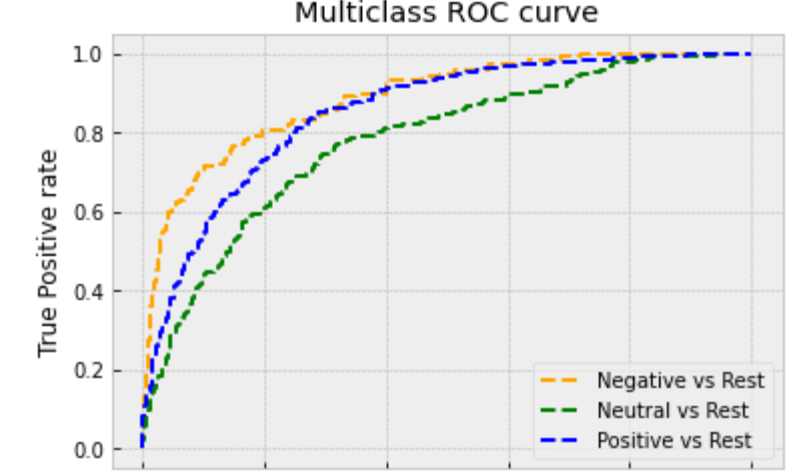
In [8]:
```python
clf_svc_3 = LinearSVC(penalty='l2', loss='squared_hinge', dual=False, tol=0.0001, C=1.0, multi_class='ovr',
                      fit_intercept=False, intercept_scaling=1, class_weight=None, verbose=0, random_state=Nor
clf_svc_3.fit(X_train_smt, y_train_smt)
pred_svc_3 = clf_svc_3.predict(X_test)
estim_prob_svc_3 = np.array(clf_svc_3.decision_function(
    X_test))  # decision is a voting function
pred_prob_svc_3 = np.exp(estim_prob_svc_3)/np.sum(np.exp(estim_prob_svc_3),
                                                  axis=1, keepdims=True)  # softmax after the voting
```

In [9]:
```python
print('Predicted classes:', clf_svc_3.classes_)
print('Average accuracy :', np.mean(pred_svc_3 == y_test)*100)
print('Train accuracy :', (clf_svc_3.score(
    X_train_smt, y_train_smt))*100)
print('Test accuracy :', (clf_svc_3.score(
    X_test, y_test))*100)

print('\n CONFUSION MATRIX')
print(confusion_matrix(y_test, pred_svc_3))
print('\n CLASSIFICATION REPORT')
print(classification_report(y_test, pred_svc_3))
```

```
Predicted classes: ['Negative' 'Neutral' 'Positive']
Average accuracy : 87.58037846775674
Train accuracy : 97.2320783231487
Test accuracy : 87.58037846775674

 CONFUSION MATRIX
[[  56   26   37]
 [  37   93  120]
 [  95  361 4618]]

 CLASSIFICATION REPORT
              precision    recall  f1-score   support

    Negative       0.30      0.47      0.36       119
     Neutral       0.19      0.37      0.25       250
    Positive       0.97      0.91      0.94      5074

    accuracy                           0.88      5443
   macro avg       0.49      0.58      0.52      5443
weighted avg       0.92      0.88      0.89      5443
```

In [10]:
```python
fpr = {}
tpr = {}
thresh = {}

fpr[0], tpr[0], thresh[0] = roc_curve(
    y_test, pred_prob_svc_3[:, 0], pos_label='Negative')
fpr[1], tpr[1], thresh[1] = roc_curve(
    y_test, pred_prob_svc_3[:, 1], pos_label='Neutral')
fpr[2], tpr[2], thresh[2] = roc_curve(
    y_test, pred_prob_svc_3[:, 2], pos_label='Positive')

# plotting
plt.plot(fpr[0], tpr[0], linestyle='--',
         color='orange', label='Negative vs Rest')
plt.plot(fpr[1], tpr[1], linestyle='--',
         color='green', label='Neutral vs Rest')
plt.plot(fpr[2], tpr[2], linestyle='--',
         color='blue', label='Positive vs Rest')
plt.title('Multiclass ROC curve')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive rate')
plt.legend(loc='best')
```

Out[10]: `<matplotlib.legend.Legend at 0x7f5ebdb3aad0>`



Loss=hinge, fit_intercept=False

In [11]:
```python
clf_svc_4 = LinearSVC(penalty='l2', loss='hinge', dual=True, tol=0.0001, C=1.0, multi_class='ovr',
                      fit_intercept=False, intercept_scaling=1, class_weight=None, verbose=0, random_state=Nor
clf_svc_4.fit(X_train_smt, y_train_smt)
pred_svc_4 = clf_svc_4.predict(X_test)
estim_prob_svc_4 = np.array(clf_svc_4.decision_function(
    X_test))  # decision is a voting function
pred_prob_svc_4 = np.exp(estim_prob_svc_4)/np.sum(np.exp(estim_prob_svc_4),
                                                  axis=1, keepdims=True)  # softmax after the voting
```

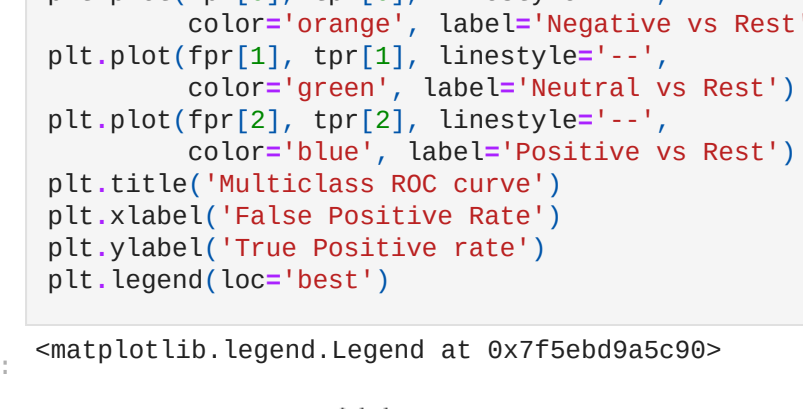
```
/usr/local/lib/python3.10/dist-packages/sklearn/svm/_base.py:1225: ConvergenceWarning: Liblinear failed to con
verge, increase the number of iterations.
  warnings.warn(
```

In [12]:
```python
print('Predicted classes:', clf_svc_4.classes_)
print('Average accuracy :', np.mean(pred_svc_4 == y_test)*100)
print('Train accuracy :', (clf_svc_4.score(
    X_train_smt, y_train_smt))*100)
print('Test accuracy :', (clf_svc_4.score(
    X_test, y_test))*100)

print('\n CONFUSION MATRIX')
print(confusion_matrix(y_test, pred_svc_4))
print('\n CLASSIFICATION REPORT')
print(classification_report(y_test, pred_svc_4))
```

```
Predicted classes: ['Negative' 'Neutral' 'Positive']
Average accuracy : 86.8822340620981
Train accuracy : 96.1150535514817
Test accuracy : 86.8822340620981

 CONFUSION MATRIX
[[  53   33   33]
 [  37  101  112]
 [  84  415 4575]]

 CLASSIFICATION REPORT
              precision    recall  f1-score   support

    Negative       0.30      0.45      0.36       119
     Neutral       0.18      0.40      0.25       250
    Positive       0.97      0.90      0.93      5074

    accuracy                           0.87      5443
   macro avg       0.49      0.58      0.52      5443
weighted avg       0.92      0.87      0.89      5443
```

In [13]:
```python
fpr = {}
tpr = {}
thresh = {}

fpr[0], tpr[0], thresh[0] = roc_curve(
    y_test, pred_prob_svc_4[:, 0], pos_label='Negative')
fpr[1], tpr[1], thresh[1] = roc_curve(
    y_test, pred_prob_svc_4[:, 1], pos_label='Neutral')
fpr[2], tpr[2], thresh[2] = roc_curve(
    y_test, pred_prob_svc_4[:, 2], pos_label='Positive')

# plotting
plt.plot(fpr[0], tpr[0], linestyle='--',
         color='orange', label='Negative vs Rest')
plt.plot(fpr[1], tpr[1], linestyle='--',
         color='green', label='Neutral vs Rest')
plt.plot(fpr[2], tpr[2], linestyle='--',
         color='blue', label='Positive vs Rest')
plt.title('Multiclass ROC curve')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive rate')
plt.legend(loc='best')
```

Out[13]: `<matplotlib.legend.Legend at 0x7f5ebd9a5c90>`



Dual=False, class_weight=Dict

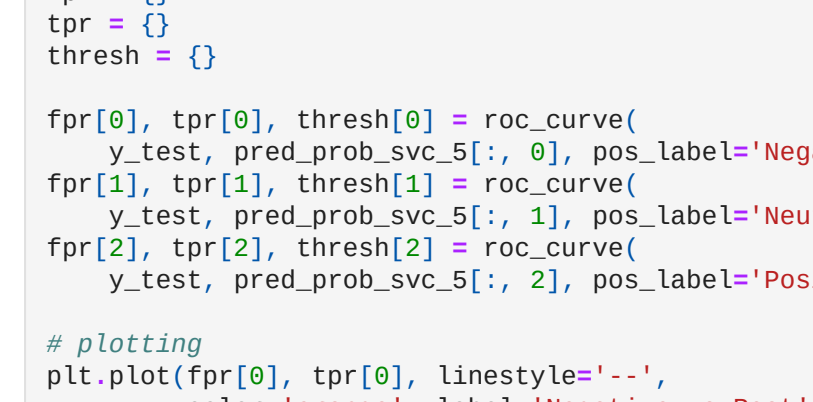
In [14]:
```python
clf_svc_5 = LinearSVC(penalty='l2', loss='squared_hinge', dual=False, tol=0.0001, C=1.0, multi_class='ovr',
                      fit_intercept=True, intercept_scaling=1, class_weight={'Negative': 0.2, 'Neutral': 0.5,
clf_svc_5.fit(X_train_smt, y_train_smt)
pred_svc_5 = clf_svc_5.predict(X_test)
estim_prob_svc_5 = np.array(clf_svc_5.decision_function(
    X_test))  # decision is a voting function
pred_prob_svc_5 = np.exp(estim_prob_svc_5)/np.sum(np.exp(estim_prob_svc_5),
                                                  axis=1, keepdims=True)  # softmax after the voting
```

In [15]:
```python
print('Predicted classes:', clf_svc_5.classes_)
print('Average accuracy :', np.mean(pred_svc_5 == y_test)*100)
print('Train accuracy :', (clf_svc_5.score(
    X_train_smt, y_train_smt))*100)
print('Test accuracy :', (clf_svc_5.score(
    X_test, y_test))*100)

print('\n CONFUSION MATRIX')
print(confusion_matrix(y_test, pred_svc_5))
print('\n CLASSIFICATION REPORT')
print(classification_report(y_test, pred_svc_5))
```

```
Predicted classes: ['Negative' 'Neutral' 'Positive']
Average accuracy : 89.10527282748484
Train accuracy : 97.13844536434719
Test accuracy : 89.10527282748484

 CONFUSION MATRIX
[[  50   29   40]
 [  35   90  125]
 [  55  309 4710]]

 CLASSIFICATION REPORT
              precision    recall  f1-score   support

    Negative       0.36      0.42      0.39       119
     Neutral       0.21      0.36      0.27       250
    Positive       0.97      0.93      0.95      5074

    accuracy                           0.89      5443
   macro avg       0.51      0.57      0.53      5443
weighted avg       0.92      0.89      0.90      5443
```

In [16]:
```python
fpr = {}
tpr = {}
thresh = {}

fpr[0], tpr[0], thresh[0] = roc_curve(
    y_test, pred_prob_svc_5[:, 0], pos_label='Negative')
fpr[1], tpr[1], thresh[1] = roc_curve(
    y_test, pred_prob_svc_5[:, 1], pos_label='Neutral')
fpr[2], tpr[2], thresh[2] = roc_curve(
    y_test, pred_prob_svc_5[:, 2], pos_label='Positive')

# plotting
plt.plot(fpr[0], tpr[0], linestyle='--',
         color='orange', label='Negative vs Rest')
plt.plot(fpr[1], tpr[1], linestyle='--',
         color='green', label='Neutral vs Rest')
plt.plot(fpr[2], tpr[2], linestyle='--',
         color='blue', label='Positive vs Rest')
plt.title('Multiclass ROC curve')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive rate')
plt.legend(loc='best')
```

Out[16]: `<matplotlib.legend.Legend at 0x7f5ebda23610>`



Penalty=l1, dual=False, fit_intercept=False

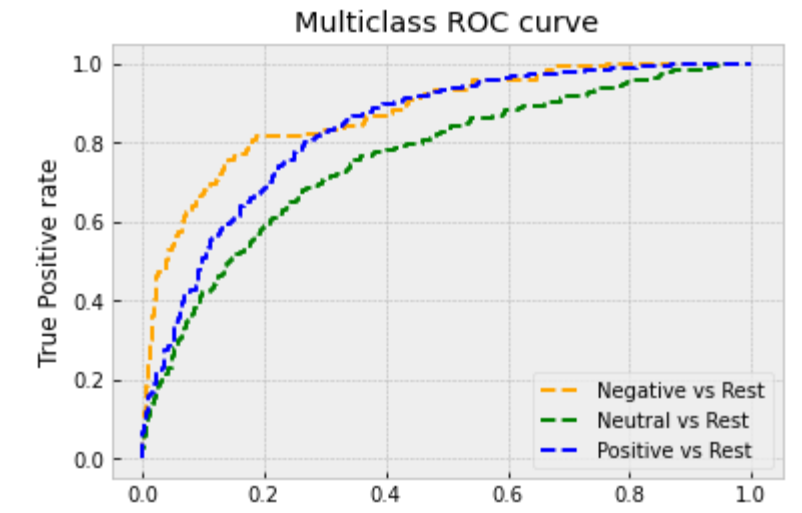
In [17]:
```python
clf_svc_6 = LinearSVC(penalty='l1', loss='squared_hinge', dual=False, tol=0.0001, C=1.0, multi_class='ovr',
                      fit_intercept=False, intercept_scaling=1, class_weight=None, verbose=0, random_state=Nor
clf_svc_6.fit(X_train_smt, y_train_smt)
pred_svc_6 = clf_svc_6.predict(X_test)
estim_prob_svc_6 = np.array(clf_svc_6.decision_function(
    X_test))  # decision is a voting function
pred_prob_svc_6 = np.exp(estim_prob_svc_6)/np.sum(np.exp(estim_prob_svc_6),
                                                  axis=1, keepdims=True)  # softmax after the voting
```

In [18]:
```python
print('Predicted classes:', clf_svc_6.classes_)
print('Average accuracy :', np.mean(pred_svc_6 == y_test)*100)
print('Train accuracy :', (clf_svc_6.score(
    X_train_smt, y_train_smt))*100)
print('Test accuracy :', (clf_svc_6.score(
    X_test, y_test))*100)

print('\n CONFUSION MATRIX')
print(confusion_matrix(y_test, pred_svc_6))
print('\n CLASSIFICATION REPORT')
print(classification_report(y_test, pred_svc_6))
```

```
Predicted classes: ['Negative' 'Neutral' 'Positive']
Average accuracy : 87.13944515891971
Train accuracy : 97.70352848413168
Test accuracy : 87.13944515891971

 CONFUSION MATRIX
[[  53   26   40]
 [  37   92  121]
 [  96  380 4598]]

 CLASSIFICATION REPORT
              precision    recall  f1-score   support

    Negative       0.28      0.45      0.35       119
     Neutral       0.18      0.37      0.25       250
    Positive       0.97      0.91      0.94      5074

    accuracy                           0.87      5443
   macro avg       0.48      0.57      0.51      5443
weighted avg       0.92      0.87      0.89      5443
```

In [19]:
```python
fpr = {}
tpr = {}
thresh = {}

fpr[0], tpr[0], thresh[0] = roc_curve(
    y_test, pred_prob_svc_6[:, 0], pos_label='Negative')
fpr[1], tpr[1], thresh[1] = roc_curve(
    y_test, pred_prob_svc_6[:, 1], pos_label='Neutral')
fpr[2], tpr[2], thresh[2] = roc_curve(
    y_test, pred_prob_svc_6[:, 2], pos_label='Positive')

# plotting
plt.plot(fpr[0], tpr[0], linestyle='--',
         color='orange', label='Negative vs Rest')
plt.plot(fpr[1], tpr[1], linestyle='--',
         color='green', label='Neutral vs Rest')
plt.plot(fpr[2], tpr[2], linestyle='--',
         color='blue', label='Positive vs Rest')
plt.title('Multiclass ROC curve')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive rate')
plt.legend(loc='best')
```

Out[19]: `<matplotlib.legend.Legend at 0x7f5ebd8af580>`



Penalty=l1, dual = False, class_weight=Dict (BEST RESULTS)

In [20]:
```python
clf_svc_7 = LinearSVC(penalty='l1', loss='squared_hinge', dual=False, tol=0.0001, C=1.0, multi_class='ovr',
                      fit_intercept=True, intercept_scaling=1, class_weight={'Negative': 0.2, 'Neutral': 0.5,
clf_svc_7.fit(X_train_smt, y_train_smt)
pred_svc_7 = clf_svc_7.predict(X_test)
estim_prob_svc_7 = np.array(clf_svc_7.decision_function(
    X_test))  # decision is a voting function
pred_prob_svc_7 = np.exp(estim_prob_svc_7)/np.sum(np.exp(estim_prob_svc_7),
                                                  axis=1, keepdims=True)  # softmax after the voting
```

In [21]:
```python
print('Predicted classes:', clf_svc_7.classes_)
print('Average accuracy :', np.mean(pred_svc_7 == y_test)*100)
print('Train accuracy :', (clf_svc_7.score(
    X_train_smt, y_train_smt))*100)
print('Test accuracy :', (clf_svc_7.score(
    X_test, y_test))*100)

print('\n CONFUSION MATRIX')
print(confusion_matrix(y_test, pred_svc_7))
print('\n CLASSIFICATION REPORT')
print(classification_report(y_test, pred_svc_7))
```

```
Predicted classes: ['Negative' 'Neutral' 'Positive']
Average accuracy : 88.59085063384164
Train accuracy : 97.51297719955319
Test accuracy : 88.59085063384164

 CONFUSION MATRIX
[[  48   28   43]
 [  33   86  131]
 [  69  317 4688]]

 CLASSIFICATION REPORT
              precision    recall  f1-score   support

    Negative       0.32      0.40      0.36       119
     Neutral       0.20      0.34      0.25       250
    Positive       0.96      0.92      0.94      5074

    accuracy                           0.89      5443
   macro avg       0.49      0.56      0.52      5443
weighted avg       0.92      0.89      0.90      5443
```

In [22]:
```python
fpr = {}
tpr = {}
thresh = {}

fpr[0], tpr[0], thresh[0] = roc_curve(
    y_test, pred_prob_svc_7[:, 0], pos_label='Negative')
fpr[1], tpr[1], thresh[1] = roc_curve(
    y_test, pred_prob_svc_7[:, 1], pos_label='Neutral')
fpr[2], tpr[2], thresh[2] = roc_curve(
    y_test, pred_prob_svc_7[:, 2], pos_label='Positive')

# plotting
plt.plot(fpr[0], tpr[0], linestyle='--',
         color='orange', label='Negative vs Rest')
plt.plot(fpr[1], tpr[1], linestyle='--',
         color='green', label='Neutral vs Rest')
plt.plot(fpr[2], tpr[2], linestyle='--',
         color='blue', label='Positive vs Rest')
plt.title('Multiclass ROC curve')
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive rate')
plt.legend(loc='best')
```

Out[22]: `<matplotlib.legend.Legend at 0x7f5ebd922770>`