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Кафедра інформатики та програмної інженерії

Звіт
з лабораторної роботи № 3 з дисципліни
«Програмування інтелектуальних інформаційних систем»

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Lab-3

Import packages

```
import pandas as pd
import category_encoders as ce
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.ensemble import RandomForestClassifier
from sklearn.model_selection import train_test_split
from sklearn.tree import plot_tree
from sklearn.metrics import mean_absolute_error, confusion_matrix,
roc_curve, roc_auc_score, classification_report, auc
from xgboost import XGBRFClassifier
import warnings
warnings.filterwarnings("ignore")
```

Auxiliary Procedures

```
def display_multiclass_roc(clf, X_test, y_test, n_classes, title,
figsize=(17, 6)):
    y_score = clf.predict_proba(X_test)

    fpr = dict()
    tpr = dict()
    roc_auc = dict()

    y_test_dummies = pd.get_dummies(y_test, drop_first=False).values
    for i in range(n_classes):
        fpr[i], tpr[i], _ = roc_curve(y_test_dummies[:, i], y_score[:,
i])
        roc_auc[i] = auc(fpr[i], tpr[i])

    fig, ax = plt.subplots(figsize=figsize)
    ax.plot([0, 1], [0, 1], 'k--')
    ax.set_xlim([0.0, 1.0])
    ax.set_ylim([0.0, 1.05])
    ax.set_xlabel('False Positive Rate')
    ax.set_ylabel('True Positive Rate')
    ax.set_title('ROC Curve for multiclass classification evaluation -
' + title)
    for i in range(n_classes):
        ax.plot(fpr[i], tpr[i], label='ROC curve (area = %0.2f) for
class %i' % (roc_auc[i], i))
    ax.legend(loc="best")
    ax.grid(alpha=.4)
```

```
    sns.despine()
    plt.show()

def display_confusion_matrix(y_test, y_pred, title, labels,
figsize=(8, 6)):
    cm = confusion_matrix(y_true = y_test, y_pred = y_pred)
    plt.figure(figsize = figsize)
    sns.heatmap(cm, annot = True, cmap='Greens', yticklabels = labels,
xticklabels = labels, fmt='g')
    plt.xlabel('Predicted')
    plt.ylabel('Actual')
    plt.title('Confusion Matrix' + title)
    plt.show();
```

Import data

```
df = pd.read_csv('resources/car_evaluation.csv')
df.columns = ['buying', 'maint', 'doors', 'persons', 'lug_boot',
'safety', 'class']
df.head()
```

	buying	maint	doors	persons	lug_boot	safety	class
0	vhigh	vhigh	2	2	small	med	unacc
1	vhigh	vhigh	2	2	small	high	unacc
2	vhigh	vhigh	2	2	med	low	unacc
3	vhigh	vhigh	2	2	med	med	unacc
4	vhigh	vhigh	2	2	med	high	unacc

Data preprocessing

```
encoder = ce.OrdinalEncoder(cols=['buying', 'maint', 'doors',
'persons', 'lug_boot', 'safety', 'class'])
df = encoder.fit_transform(df)
df.head()
```

	buying	maint	doors	persons	lug_boot	safety	class
0	1	1	1	1	1	1	1
1	1	1	1	1	1	2	1
2	1	1	1	1	2	3	1
3	1	1	1	1	2	1	1
4	1	1	1	1	2	2	1

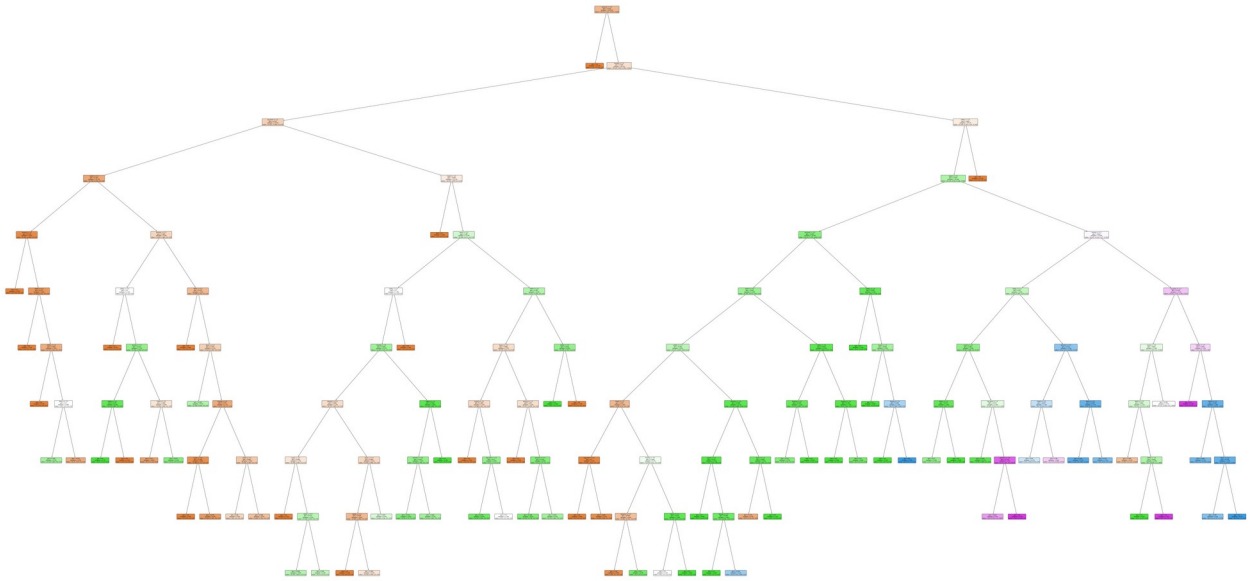
```
X = df.drop('class', axis= 1)
y = df['class'] - 1
X_train, X_test, y_train, y_test = train_test_split(X, y,
test_size=0.2, random_state=42)
```

Random Forest

```
rf = RandomForestClassifier(min_samples_split=7, random_state=42)
rf.fit(X_train, y_train)
y_pred = rf.predict(X_test)
print(f'Random forest mean accuracy: {rf.score(X_test, y_test)}')
print(f'Random forest mean absolute error:
{mean_absolute_error(y_test, y_pred)}')
```

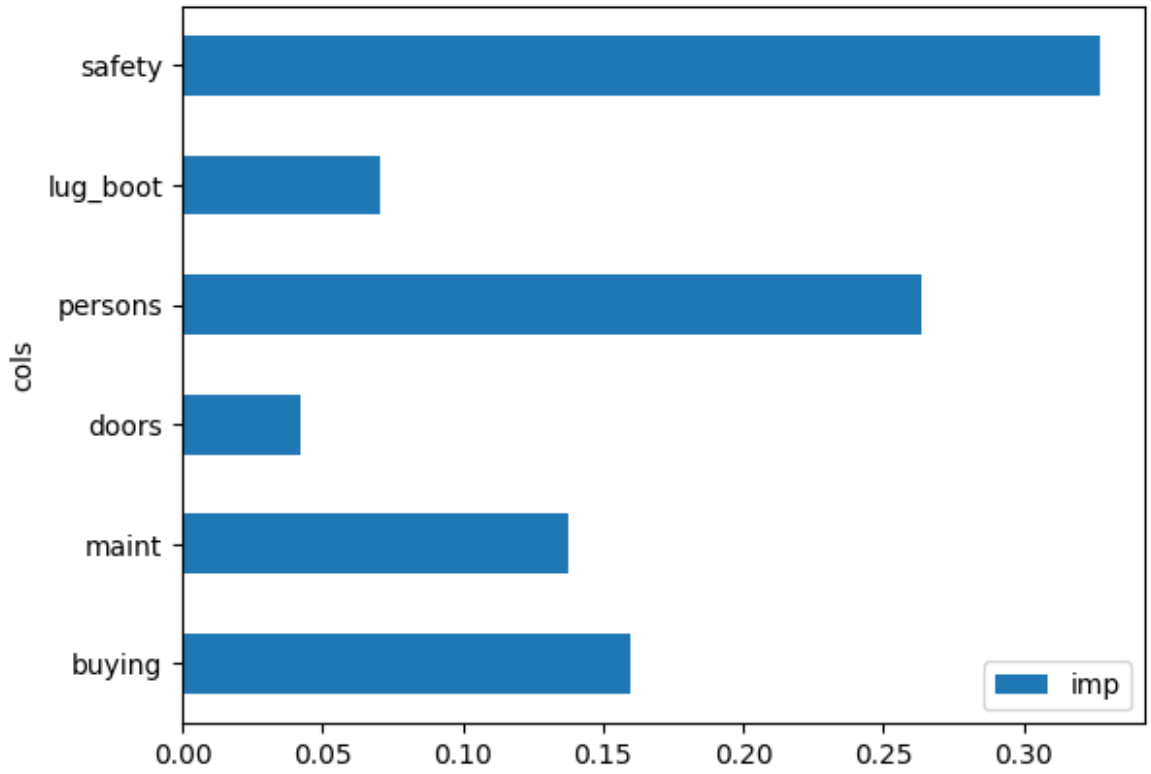
```
Random forest mean accuracy: 0.9682080924855492
Random forest mean absolute error: 0.03757225433526012
```

```
plt.figure(figsize=(150, 75))
plot_tree(rf.estimators_[0], filled=True, feature_names=X.columns,
rounded=True, proportion=True)
plt.savefig('random_forest_decision_tree.png')
plt.show()
```



```
pd.DataFrame(dict(cols=['buying', 'maint', 'doors', 'persons',
'lug_boot', 'safety'], imp=rf.feature_importances_)).plot('cols',
'imp', 'barh')
```

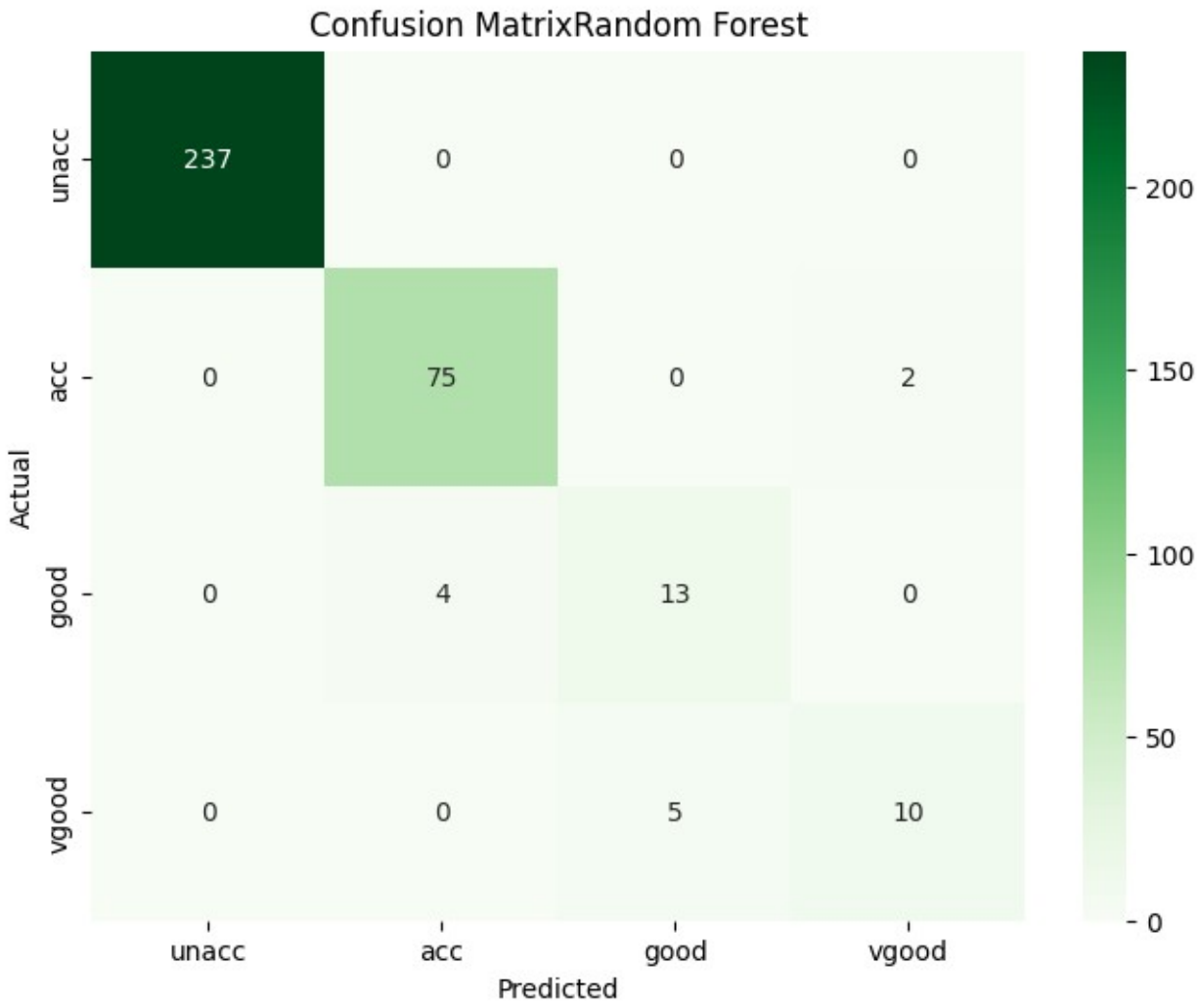
```
<Axes: ylabel='cols'>
```



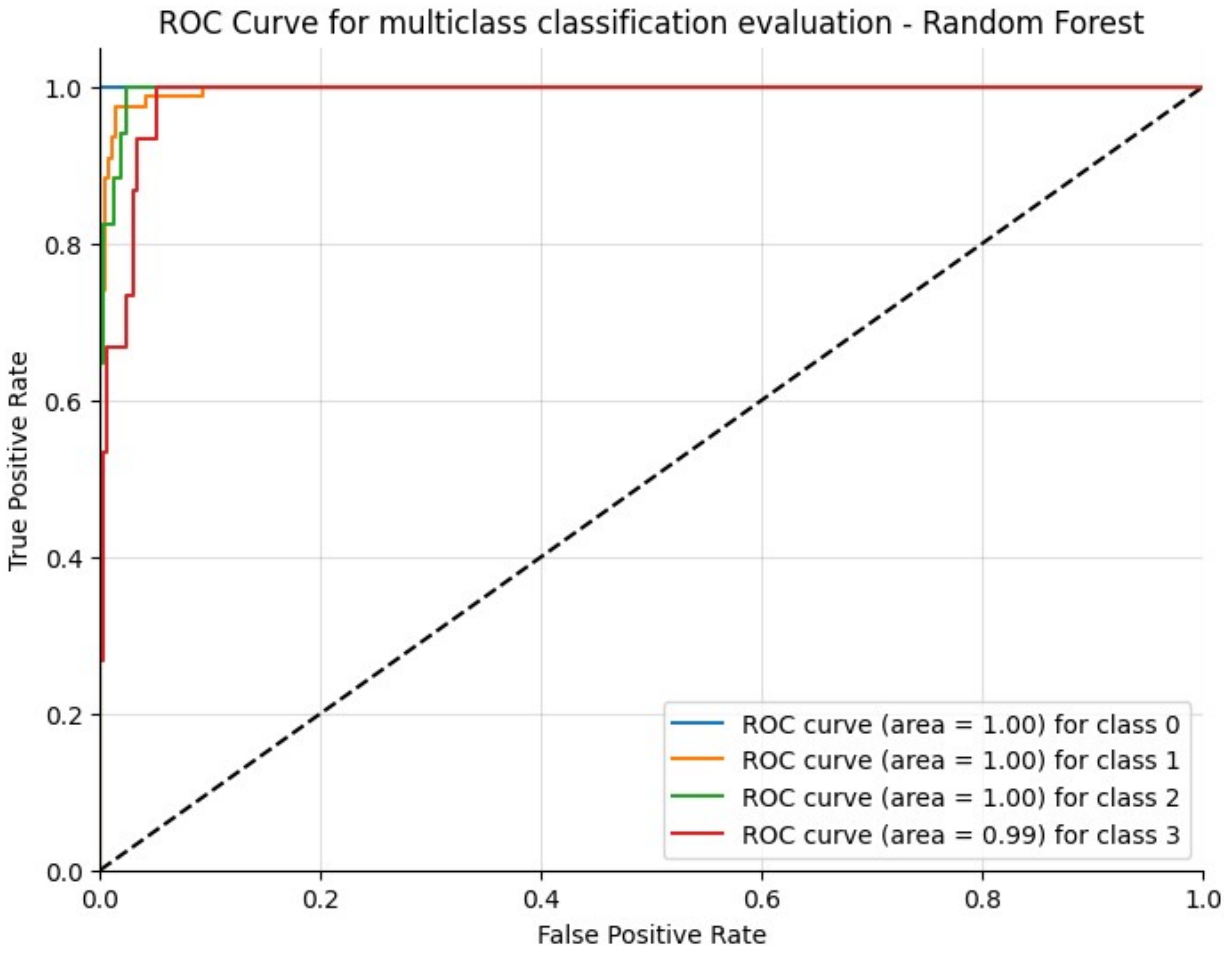

```
print(classification_report(y_test, y_pred, target_names=['unacc',
'acc', 'good', 'vgood']))
```

```
              precision    recall  f1-score   support

       unacc       1.00      1.00      1.00       237
         acc       0.95      0.97      0.96        77
        good       0.72      0.76      0.74        17
       vgood       0.83      0.67      0.74        15

    accuracy                           0.97       346
   macro avg       0.88      0.85      0.86       346
weighted avg       0.97      0.97      0.97       346
```

```
display_confusion_matrix(y_test, y_pred, "Random Forest", ['unacc',
'acc', 'good', 'vgood'], (8, 6))
```




```
display_multiclass_roc(rf, X_test, y_test, 4, "Random Forest", (8, 6))
```



XGBoost

```
xgb = XGBRFClassifier(random_state=42)
xgb.fit(X_train, y_train)
y_pred = xgb.predict(X_test)
print(f'XGBoost mean accuracy: {xgb.score(X_test, y_test)}')
print(f'XGBoost mean absolute error: {mean_absolute_error(y_test,
y_pred)}')
```

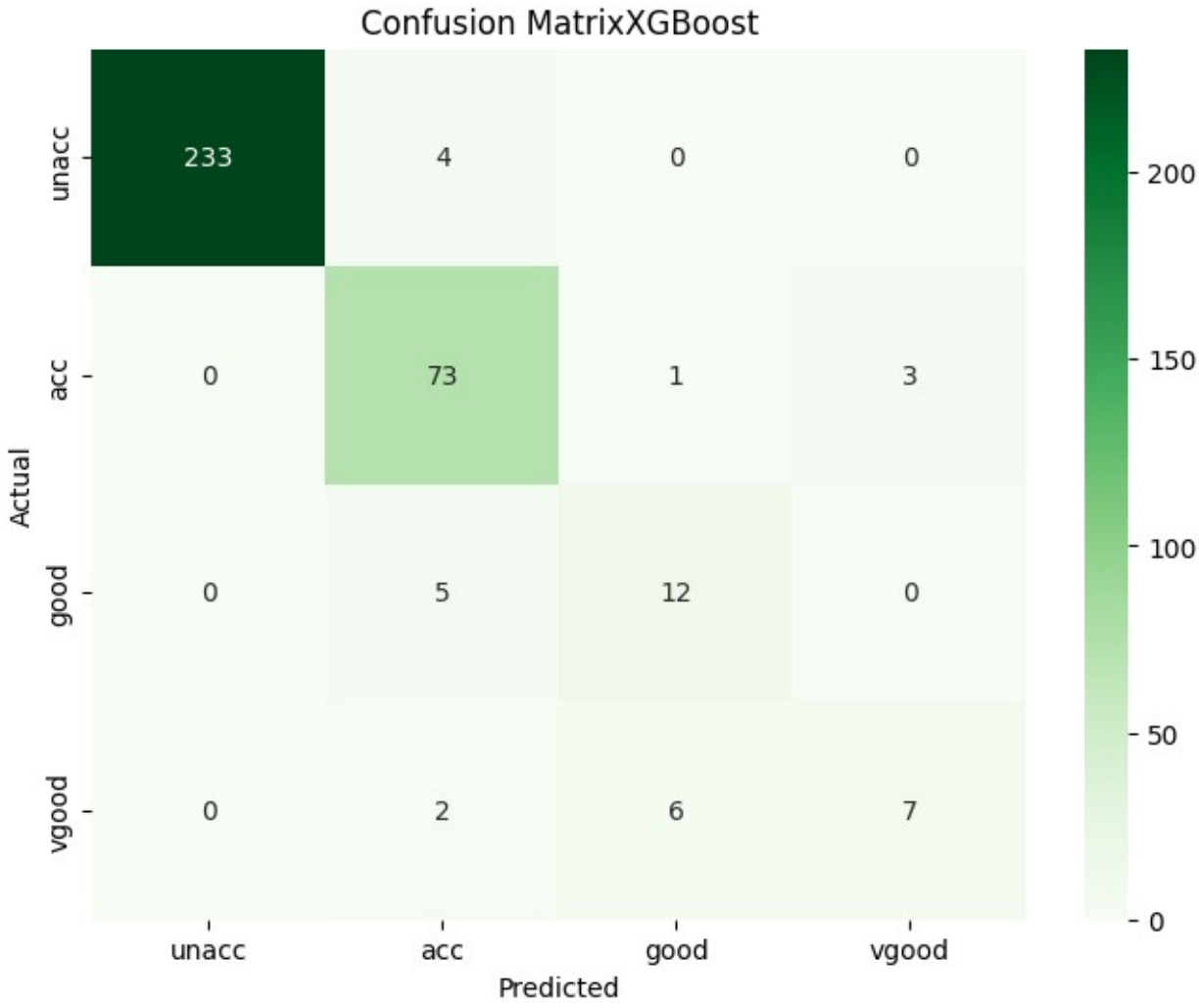
```
XGBoost mean accuracy: 0.9393063583815029
XGBoost mean absolute error: 0.07514450867052024
```

```
print(classification_report(y_test, y_pred, target_names=['unacc',
'acc', 'good', 'vgood']))
```

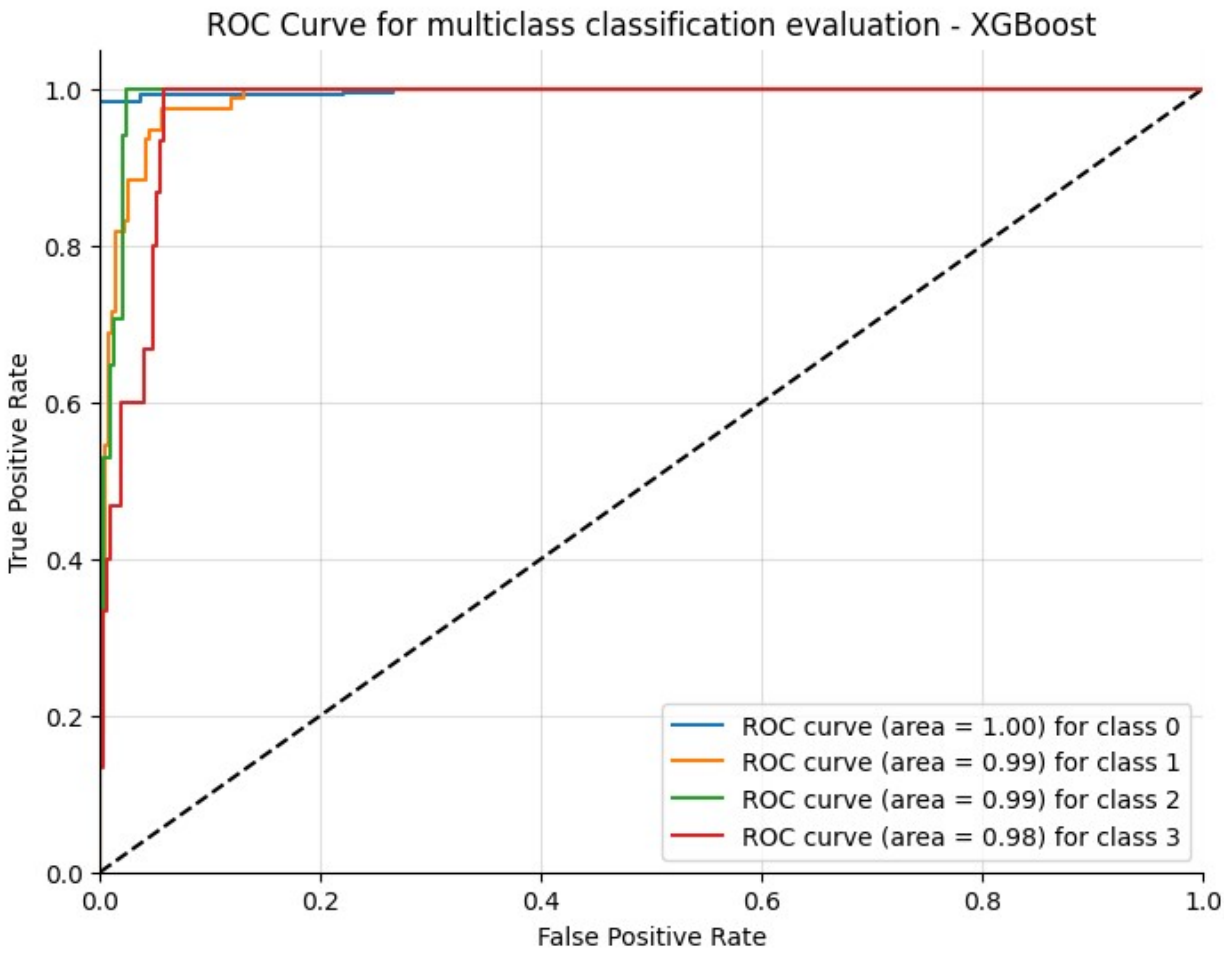
```
              precision    recall  f1-score   support

       unacc       1.00      0.98      0.99       237
         acc       0.87      0.95      0.91        77
        good       0.63      0.71      0.67        17
       vgood       0.70      0.47      0.56        15
```

```
    accuracy                           0.94       346
   macro avg       0.80      0.78      0.78       346
weighted avg       0.94      0.94      0.94       346
```

```
display_confusion_matrix(y_test, y_pred, "XGBoost", ['unacc', 'acc',
'good', 'vgood'], (8, 6))
```




```
display_multiclass_roc(xgb, X_test, y_test, 4, "XGBoost", (8, 6))
```


ROC Curve for multiclass classification evaluation - XGBoost
True Positive Rate
False Positive Rate
0.0
0.2
0.4
0.6
0.8
1.0
ROC curve (area = 1.00) for class 0
ROC curve (area = 0.99) for class 1
ROC curve (area = 0.99) for class 2
ROC curve (area = 0.98) for class 3