

wine_anomaly_detection

2020 年 6 月 30 日

1 使用 wine_benchmark 做异常点检测

```
[1]: import pyod
import numpy as np
import pandas as pd
from sklearn.decomposition import PCA
import tensorflow
```

```
[2]: meta_data = pd.read_csv('D:/homework_for_data_mining/outlier detection/wine/
↳ meta_data/wine.preproc.csv', encoding='utf-8')
```

```
[3]: ground_truth = meta_data[['ground.truth']]
normal = ground_truth[ground_truth['ground.truth']=='nominal']
anomaly = ground_truth[ground_truth['ground.truth']=='anomaly']
normal_len = len(normal.index)
anomaly_len = len(anomaly.index)
total_len = normal_len + anomaly_len
print('nominal ', normal_len/total_len)
print('anamaly ', anomaly_len/total_len)
```

```
nominal  0.6330614129598277
anamaly  0.3669385870401724
```

2 按照 9:1 的比例划分训练集和测试集

保证在训练集上异常点的比例小于正常点，把 benchmark 中的异常点的 label 转化为二值，1 代表异常点，0 代表正常点

```

[7]: test_set_index, train_set_index = [], []
normal_index = normal.index
total_normal_index = np.arange(normal_len)
normal_test_index = np.random.choice(total_normal_index, size=int(normal_len * 0.1), replace=False)
normal_train_index = [_index for _index in total_normal_index if _index not in normal_test_index]
test_set_index = normal_index[normal_test_index]
train_set_index = normal_index[normal_train_index]

anomaly_index = anomaly.index
total_anomaly_index = np.arange(anomaly_len)
anomaly_test_index = np.random.choice(total_anomaly_index, size=int(anomaly_len*0.1), replace=False)
anomaly_train_index = [_index for _index in total_anomaly_index if _index not in anomaly_test_index]
test_set_index = test_set_index.append(anomaly_index[anomaly_test_index])
train_set_index = train_set_index.append(anomaly_index[anomaly_train_index])

train_set_feature = meta_data.loc[train_set_index, ['fixed.acidity', 'volatile.acidity', 'citric.acid', 'residual.sugar', 'chlorides', 'free.sulfur.dioxide', 'total.sulfur.dioxide', 'density', 'pH', 'sulphates', 'alcohol']]
train_set_feature = np.array(train_set_feature.values.tolist())
test_set_feature = meta_data.loc[test_set_index, ['fixed.acidity', 'volatile.acidity', 'citric.acid', 'residual.sugar', 'chlorides', 'free.sulfur.dioxide', 'total.sulfur.dioxide', 'density', 'pH', 'sulphates', 'alcohol']]
test_set_feature = np.array(test_set_feature.values.tolist())
# print(test_set_index)
train_set_groundtruth = meta_data.loc[train_set_index, 'ground.truth'].values.tolist()
test_set_groundtruth = meta_data.loc[test_set_index, 'ground.truth'].values.tolist()
y_train_label = np.array([0 if _label == 'nominal' else 1 for _label in train_set_groundtruth ])
y_test_label = np.array([0 if _label == 'nominal' else 1 for _label in test_set_groundtruth ])

```

3 使用 KNN 进行异常点分析

3.1 计算 ROC-AUC 分数

```
[8]: from pyod.models.knn import KNN
from pyod.utils.utility import precision_n_scores
from sklearn.metrics import roc_auc_score

clf = KNN()
clf.fit(train_set_feature)
y_train_pred = clf.labels_
y_train_score = clf.decision_scores_

y_test_pred = clf.predict(test_set_feature)
y_test_score = clf.decision_function(test_set_feature)

print('Train AUC:{roc}, precision:{prn}'.format(
    roc=roc_auc_score(y_train_label, y_train_score),
    prn=precision_n_scores(y_train_label, y_train_score)))

print('Test AUC:{roc}, precision:{prn}'.format(
    roc=roc_auc_score(y_test_label, y_test_score),
    prn=precision_n_scores(y_test_label, y_test_score)))
```

Train AUC:0.5527476907234282, precision:0.40882597835137385

Test AUC:0.5488403211418376, precision:0.39097744360902253

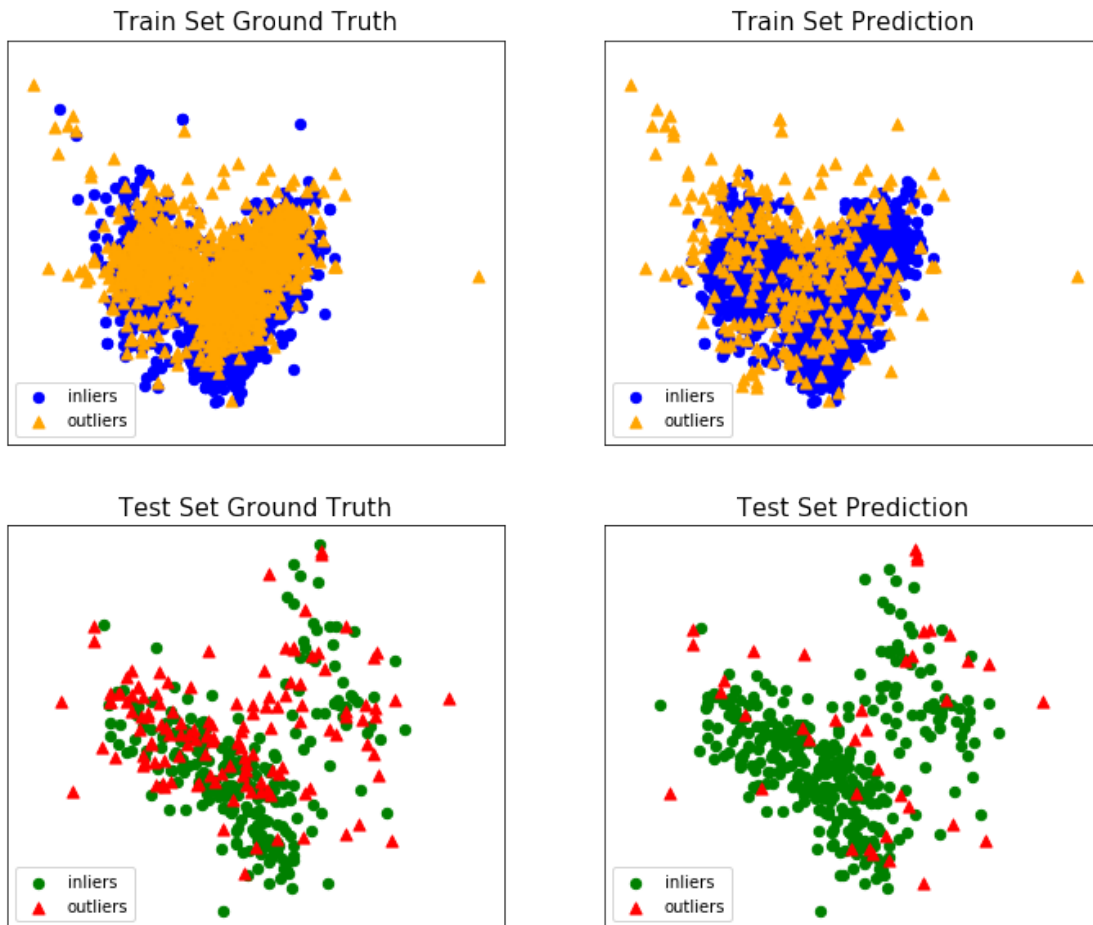
可以看出，使用 KNN 方法在训练集和测试集上的 AUC 分数都在 0.5-0.7 之间，异常点识别效果较低。

3.2 使用 PCA 对数据特征进行降维后可视化

```
[9]: from pyod.utils.example import visualize
pca = PCA(n_components=2)
reduced_train_set_feature = pca.fit_transform(train_set_feature)
pca_test = PCA(n_components=2)
reduced_test_set_feature = pca_test.fit_transform(test_set_feature)
clf_name = 'KNN'
```

```
visualize(clf_name, reduced_train_set_feature, y_train_label,   
→reduced_test_set_feature, y_test_label, y_train_pred, y_test_pred,   
→show_figure=True, save_figure=False)
```

Demo of KNN Detector



KNN 方法是一种无监督的方法。从图中可以看出，使用 KNN 方法进行异常点识别的效果较差，很多异常点没有识别出来。

4 使用 IForest 进行异常点分析

4.1 计算 ROC-AUC 分数并可视化

```
[10]: from pyod.models.iforesset import IForest

clf = IForest()
clf.fit(train_set_feature)
y_train_pred = clf.labels_
y_train_score = clf.decision_scores_

y_test_pred = clf.predict(test_set_feature)
y_test_score = clf.decision_function(test_set_feature)

print('Train AUC:{roc}, precision:{prn}'.format(
    roc=roc_auc_score(y_train_label, y_train_score),
    prn=precision_n_scores(y_train_label, y_train_score)))

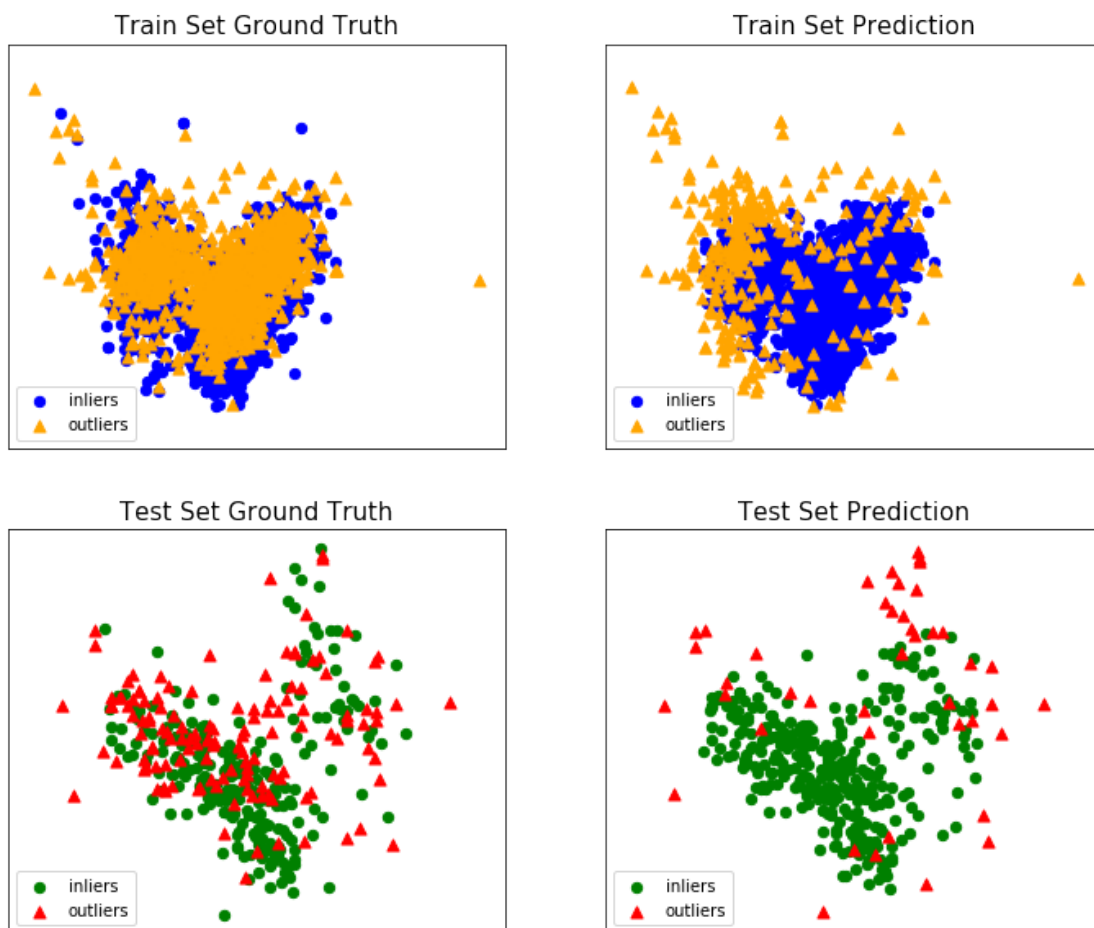
print('Test AUC:{roc}, precision:{prn}'.format(
    roc=roc_auc_score(y_test_label, y_test_score),
    prn=precision_n_scores(y_test_label, y_test_score)))

pca = PCA(n_components=2)
reduced_train_set_feature = pca.fit_transform(train_set_feature)
pca_test = PCA(n_components=2)
reduced_test_set_feature = pca_test.fit_transform(test_set_feature)
clf_name = 'IForest'
visualize(clf_name, reduced_train_set_feature, y_train_label,
    ↳reduced_test_set_feature, y_test_label, y_train_pred, y_test_pred,
    ↳show_figure=True, save_figure=False)
```

Train AUC:0.5477588804141571, precision:0.40882597835137385

Test AUC:0.594335414808207, precision:0.45864661654135336

Demo of IForest Detector



可以看出，IForest 算法对于大部分明显偏离正常点的数据都识别成了异常点。如果从降维的两个主成分的角度来看，IForest 是合格的，因为他确实把远离中心的异常点都识别了出来，但是很明显 **groundtruth** 不是这么定义的，一些异常点在图像中也在正常点的内部。理论上来说，IForest 是适合高维数据的，但是在这个 **benchmark** 上，IForest 不适合。这可能是由于在 IForest 算法中，每次切数据空间都是随机选取一个维度，建完树后仍然有大量的维度信息没有被使用，导致算法在高维空间下可靠性降低。

5 使用 LOF 进行异常点分析

5.1 计算 ROC-AUC 分数并可视化

```
[11]: from pyod.models.lof import LOF

clf = LOF()
clf.fit(train_set_feature)
y_train_pred = clf.labels_
y_train_score = clf.decision_scores_

y_test_pred = clf.predict(test_set_feature)
y_test_score = clf.decision_function(test_set_feature)

print('Train AUC:{roc}, precision:{prn}'.format(
    roc=roc_auc_score(y_train_label, y_train_score),
    prn=precision_n_scores(y_train_label, y_train_score)))

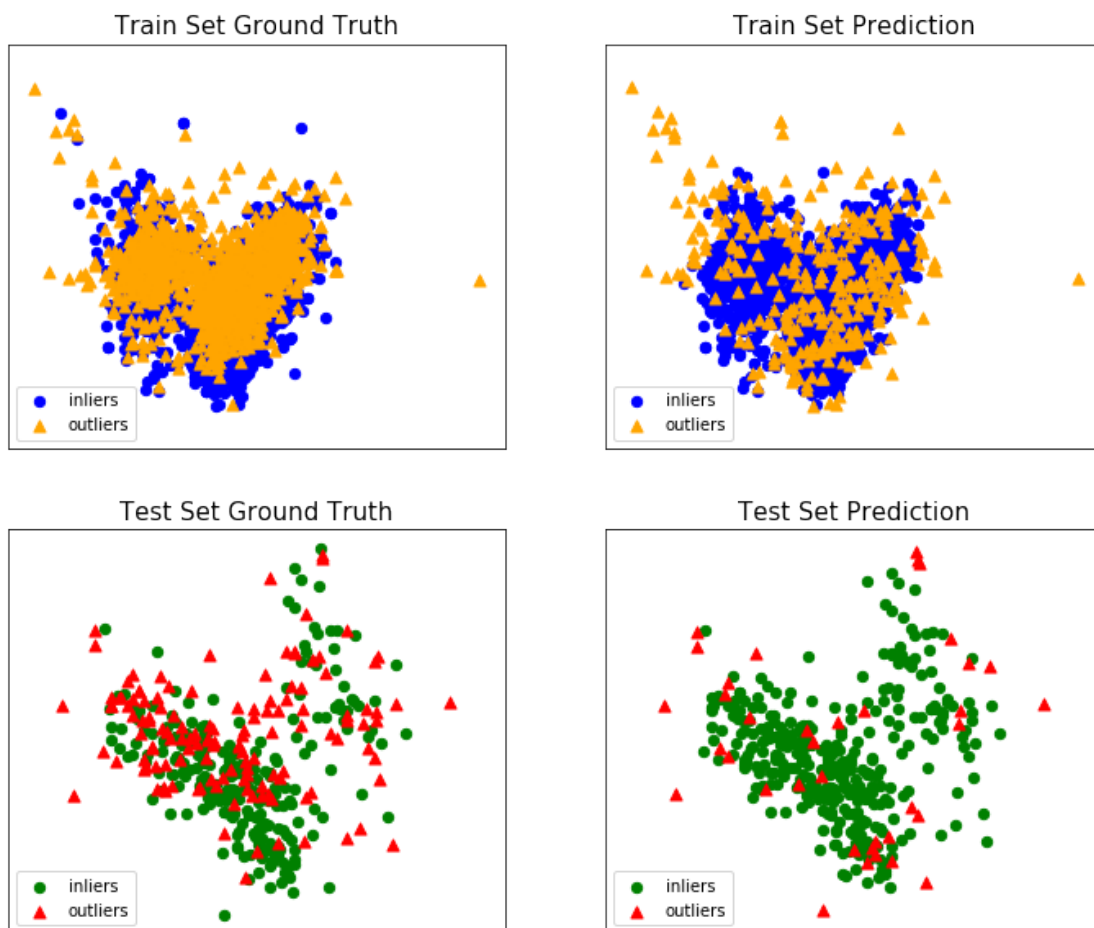
print('Test AUC:{roc}, precision:{prn}'.format(
    roc=roc_auc_score(y_test_label, y_test_score),
    prn=precision_n_scores(y_test_label, y_test_score)))

pca = PCA(n_components=2)
reduced_train_set_feature = pca.fit_transform(train_set_feature)
pca_test = PCA(n_components=2)
reduced_test_set_feature = pca_test.fit_transform(test_set_feature)
clf_name = 'LOF'
visualize(clf_name, reduced_train_set_feature, y_train_label,
    ↪reduced_test_set_feature, y_test_label, y_train_pred, y_test_pred,
    ↪show_figure=True, save_figure=False)
```

Train AUC:0.5485427247882586, precision:0.4096586178184846

Test AUC:0.5582706766917294, precision:0.40601503759398494

Demo of LOF Detector



尽管 LOF 算法的 AUC 值也没有很高，但是 LOF 算法能够把一些在高维上异常，但是在降维后的空间中处于正常点内部的异常点检查出来。如果，LOF 算法能够把一些绿色区域的红色点检测出来，同样对于明显的异常点有准确的检测。在这一点上，LOF 算法要比 IForest 算法要好。

6 使用 OCSVM 进行异常点分析

6.1 计算 ROC-AUC 分数并可视化

```
[12]: from pyod.models.ocsvm import OCSVM

clf = OCSVM()
clf.fit(train_set_feature)
y_train_pred = clf.labels_
y_train_score = clf.decision_scores_

y_test_pred = clf.predict(test_set_feature)
y_test_score = clf.decision_function(test_set_feature)

print('Train AUC:{roc}, precision:{prn}'.format(
    roc=roc_auc_score(y_train_label, y_train_score),
    prn=precision_n_scores(y_train_label, y_train_score)))

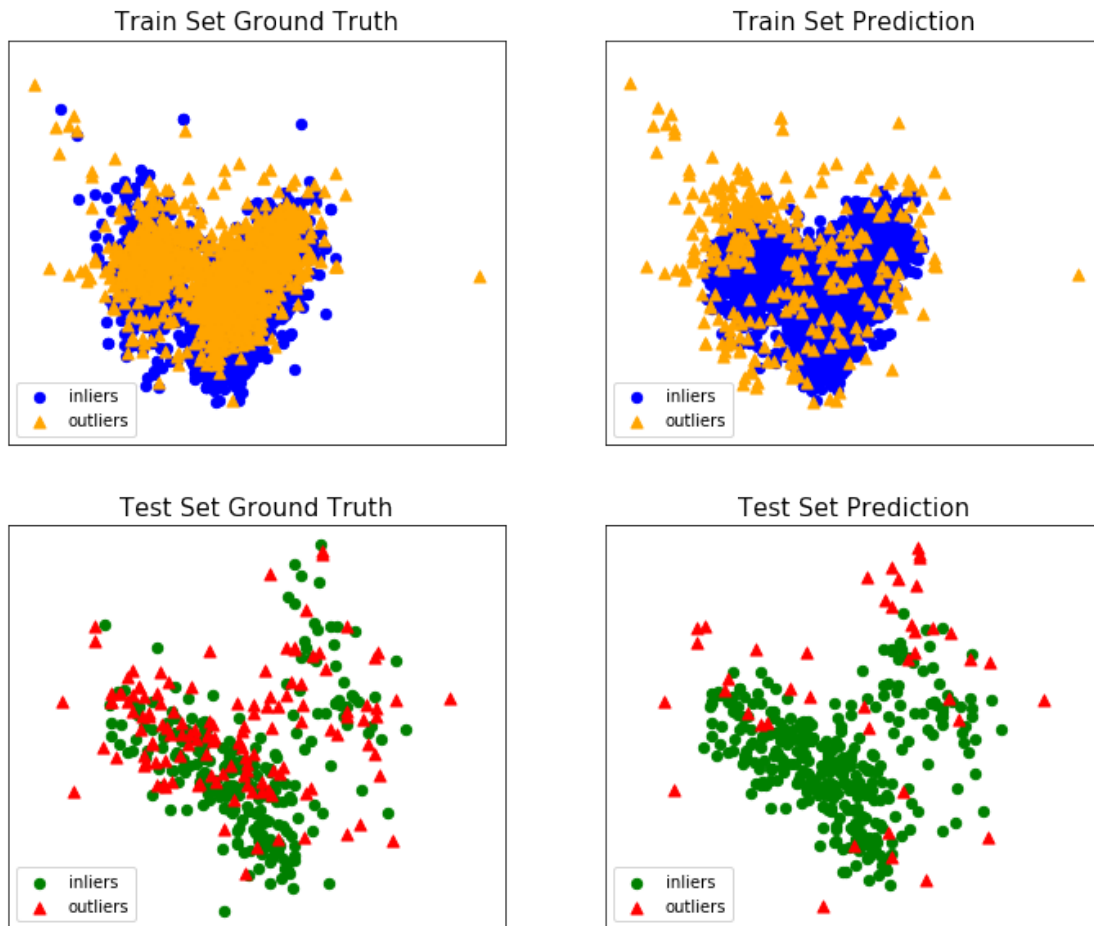
print('Test AUC:{roc}, precision:{prn}'.format(
    roc=roc_auc_score(y_test_label, y_test_score),
    prn=precision_n_scores(y_test_label, y_test_score)))

pca = PCA(n_components=2)
reduced_train_set_feature = pca.fit_transform(train_set_feature)
pca_test = PCA(n_components=2)
reduced_test_set_feature = pca_test.fit_transform(test_set_feature)
clf_name = 'OCSVM'
visualize(clf_name, reduced_train_set_feature, y_train_label,
    ↳reduced_test_set_feature, y_test_label, y_train_pred, y_test_pred,
    ↳show_figure=True, save_figure=False)
```

Train AUC:0.5395534975737128, precision:0.4063280599500416

Test AUC:0.5756340002548745, precision:0.44360902255639095

Demo of OCSVM Detector



7 全 benchmark 异常值分析

最后，在所有 wave_benchmark 上，使用 KNN、IForest、LOF 和 OCSVM 异常值检测算法进行异常值检测，并把评估结果存储在 wine_benchmark_result.csv 中。

```
[18]: import os
import csv

root_path = 'D:/homework_for_data_mining/outlier detection/wine/benchmarks/'
csv_file_name = 'D:/homework_for_data_mining/outlier detection/wine/
↳ wine_benchmark_result.csv'
```

```

csv_file = open(csv_file_name, 'w', newline='')
csv_writer = csv.writer(csv_file)
csv_writer.writerow(['file name', 'KNN-ROC', 'IForest-ROC', 'LOF-ROC',
↳ 'OCSVM-ROC'])
all_file = os.listdir(root_path)

for file_name in all_file:
    file_path = root_path + file_name
    meta_data = pd.read_csv(file_path, encoding='utf-8')
    ground_truth = meta_data[['ground.truth']]
    normal = ground_truth[ground_truth['ground.truth']=='nominal']
    anomaly = ground_truth[ground_truth['ground.truth']=='anomaly']
    normal_len = len(normal.index)
    anomaly_len = len(anomaly.index)
    total_len = normal_len + anomaly_len
    print(file_name)
    if anomaly_len >= normal_len or anomaly_len <=10:
        continue

    test_set_index, train_set_index = [], []
    normal_index = normal.index
    total_normal_index = np.arange(normal_len)

    normal_test_index = np.random.choice(total_normal_index,
↳ size=int(normal_len * 0.1), replace=False)
    normal_train_index = [_index for _index in total_normal_index if _index not
↳ in normal_test_index]
    test_set_index = normal_index[normal_test_index]
    train_set_index = normal_index[normal_train_index]
    anomaly_index = anomaly.index
    total_anomaly_index = np.arange(anomaly_len)
    anomaly_test_index = np.random.choice(total_anomaly_index,
↳ size=int(anomaly_len*0.1), replace=False)
    anomaly_train_index = [_index for _index in total_anomaly_index if _index
↳ not in anomaly_test_index]
    test_set_index = test_set_index.append(anomaly_index[anomaly_test_index])

```

```

train_set_index = train_set_index.append(anomaly_index[anomaly_train_index])

train_set_feature = meta_data.loc[train_set_index, ['fixed.
↪acidity', 'volatile.acidity', 'citric.acid', 'residual.sugar', 'chlorides', 'free.
↪sulfur.dioxide', 'total.sulfur.dioxide', 'density', 'pH', 'sulphates', 'alcohol']]
train_set_feature = np.array(train_set_feature.values.tolist())
test_set_feature = meta_data.loc[test_set_index, ['fixed.acidity', 'volatile.
↪acidity', 'citric.acid', 'residual.sugar', 'chlorides', 'free.sulfur.
↪dioxide', 'total.sulfur.dioxide', 'density', 'pH', 'sulphates', 'alcohol']]
test_set_feature = np.array(test_set_feature.values.tolist())
train_set_groundtruth = meta_data.loc[train_set_index, 'ground.truth'].
↪values.tolist()
test_set_groundtruth = meta_data.loc[test_set_index, 'ground.truth'].values.
↪tolist()

y_train_label = np.array([0 if _label == 'nominal' else 1 for _label in_
↪train_set_groundtruth ])
y_test_label = np.array([0 if _label == 'nominal' else 1 for _label in_
↪test_set_groundtruth ])

# KNN method
clf = KNN()
clf.fit(train_set_feature)
y_train_pred = clf.labels_
y_train_score = clf.decision_scores_
y_test_pred = clf.predict(test_set_feature)
y_test_score = clf.decision_function(test_set_feature)
knn_roc = roc_auc_score(y_test_label, y_test_score)

# IForest method
clf = IForest()
clf.fit(train_set_feature)
y_train_pred = clf.labels_
y_train_score = clf.decision_scores_
y_test_pred = clf.predict(test_set_feature)
y_test_score = clf.decision_function(test_set_feature)
iforest_roc = roc_auc_score(y_test_label, y_test_score)

```

```

# LOF method
clf = LOF()
clf.fit(train_set_feature)
y_train_pred = clf.labels_
y_train_score = clf.decision_scores_
y_test_pred = clf.predict(test_set_feature)
y_test_score = clf.decision_function(test_set_feature)
lof_roc = roc_auc_score(y_test_label, y_test_score)

# OCSVM method
clf = OCSVM()
clf.fit(train_set_feature)
y_train_pred = clf.labels_
y_train_score = clf.decision_scores_
y_test_pred = clf.predict(test_set_feature)
y_test_score = clf.decision_function(test_set_feature)
ocsvm_roc = roc_auc_score(y_test_label, y_test_score)

csv_writer.writerow([file_name, knn_roc, iforest_roc, lof_roc, ocsvm_roc])

csv_file.close()
print('Results are saved in wine_benchmark_result.csv')

```

wine_benchmark_0001.csv
 wine_benchmark_0002.csv
 wine_benchmark_0003.csv
 wine_benchmark_0004.csv
 wine_benchmark_0005.csv
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Results are saved in wine_benchmark_result.csv
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