wave_anomaly_detection

2020 年 6 月 30 日

1 使用 wave_benchmark 做异常点检测

[2]:
```
import pyod
import numpy as np
import pandas as pd
from sklearn.decomposition import PCA
from pyod.models.knn import KNN
```

[3]:
```
meta_data = pd.read_csv('D:/homework_for_data_mining/outlier detection/wave/
 ↪meta_data/wave.preproc.csv', 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('nominal ', normal_len/total_len)
print('anamaly ', anomaly_len/total_len)
```

```
nominal  0.6686
anamaly  0.3314
```

首先看出异常点与正常点的比值是 1:2

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

[4]:
```
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, ['V','V.1','V.2','V.3','V.
↪4','V.5','V.6','V.7','V.8','V.9','V.10','V.11','V.12','V.13','V.14','V.
↪15','V.16','V.17','V.18','V.19','V.20']]
train_set_feature = np.array(train_set_feature.values.tolist())
test_set_feature = meta_data.loc[test_set_index, ['V','V.1','V.2','V.3','V.
↪4','V.5','V.6','V.7','V.8','V.9','V.10','V.11','V.12','V.13','V.14','V.
↪15','V.16','V.17','V.18','V.19','V.20']]
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 ])
```

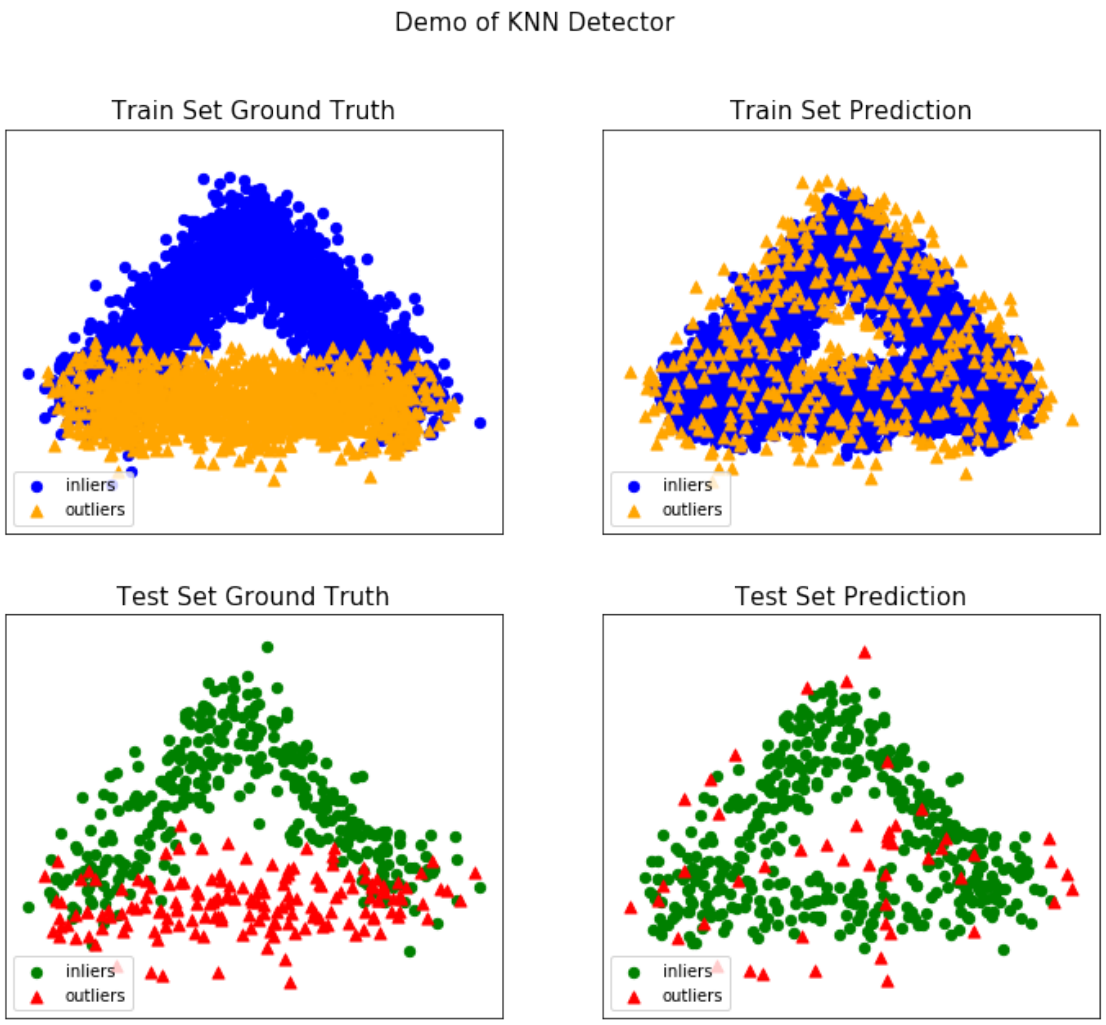
3 使用 KNN 进行异常点分析

3.1 计算 ROC-AUC 分数并可视化

[5]:
```
from pyod.utils.utility import precision_n_scores
from sklearn.metrics import roc_auc_score
from pyod.utils.example import visualize
clf = KNN()

pca = PCA(n_components=3)
analyse_train_set_feature = pca.fit_transform(train_set_feature)
pca_test = PCA(n_components=3)
analyse_test_set_feature = pca_test.fit_transform(test_set_feature)

# clf.fit(train_set_feature)
clf.fit(analyse_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)
y_test_pred = clf.predict(analyse_test_set_feature)
y_test_score = clf.decision_function(analyse_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 = '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)
```

```
Train AUC:0.5749576560755625, precision:0.4014745308310992
Test AUC:0.5591725639629831, precision:0.40606060606060607
```



由于 KNN 是一个非监督的学习方法，可以看出，在这种类别比较少，且每个类别中的样本数比较平均，且维度特征比较高的情况下，KNN 的效果不好。

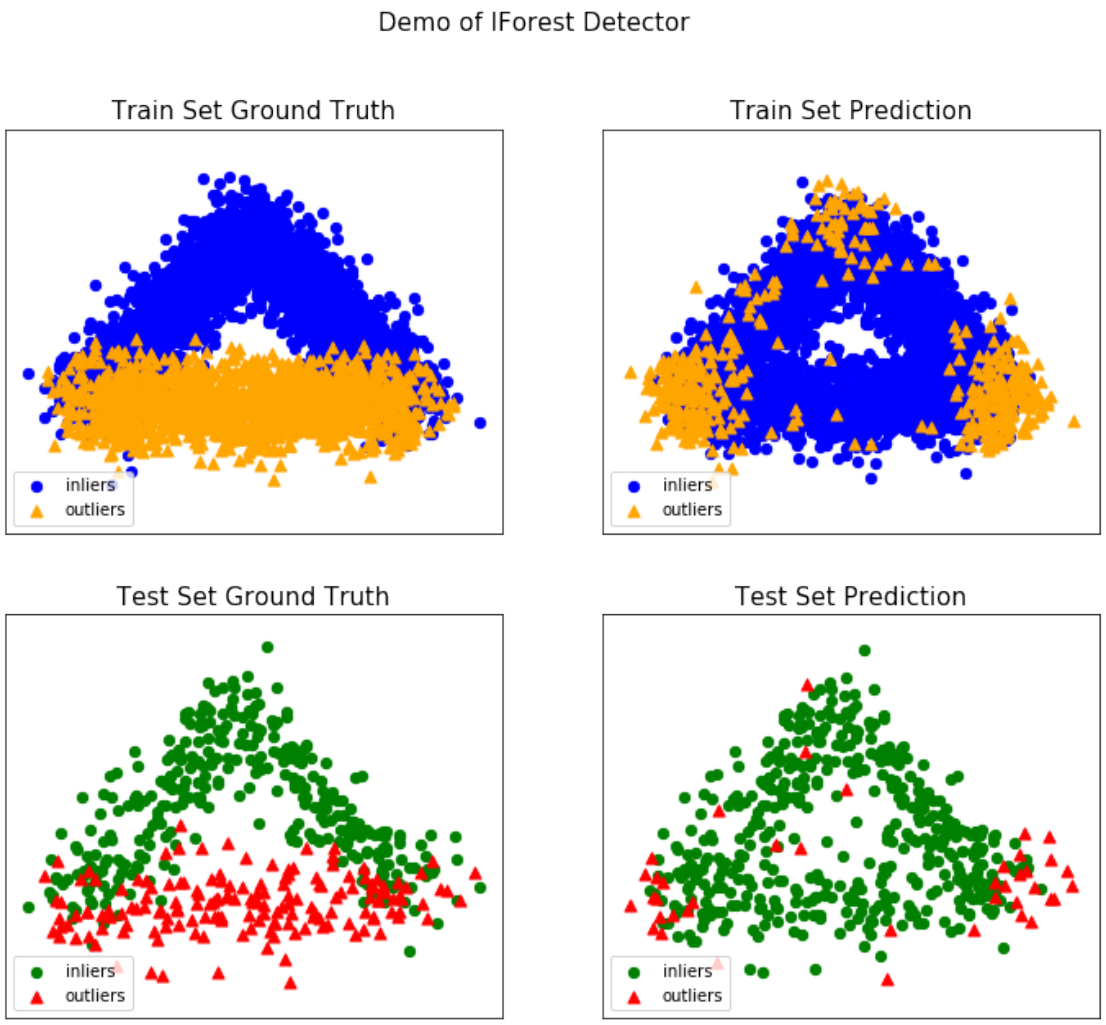
4 使用 IForest 进行异常点分析

4.1 计算 ROC-AUC 分数并可视化

[6]:
```
from pyod.models.iforest import IForest

clf = IForest()
# pca = PCA(n_components=1)
# analyse_train_set_feature = pca.fit_transform(train_set_feature)
# pca_test = PCA(n_components=1)
# analyse_test_set_feature = pca_test.fit_transform(test_set_feature)
analyse_train_set_feature = train_set_feature
analyse_test_set_feature = test_set_feature

# clf.fit(train_set_feature)
clf.fit(analyse_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)
y_test_pred = clf.predict(analyse_test_set_feature)
y_test_score = clf.decision_function(analyse_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:0.5083084081090063, precision:0.3351206434316354
Test AUC:0.514661585919071, precision:0.3333333333333333
```



在使用 IForest 算法中，可以看出，IForest 把各个类之间的边界点识别成了异常点，但是对于异常点类内部的点，IForest 没有识别出来。

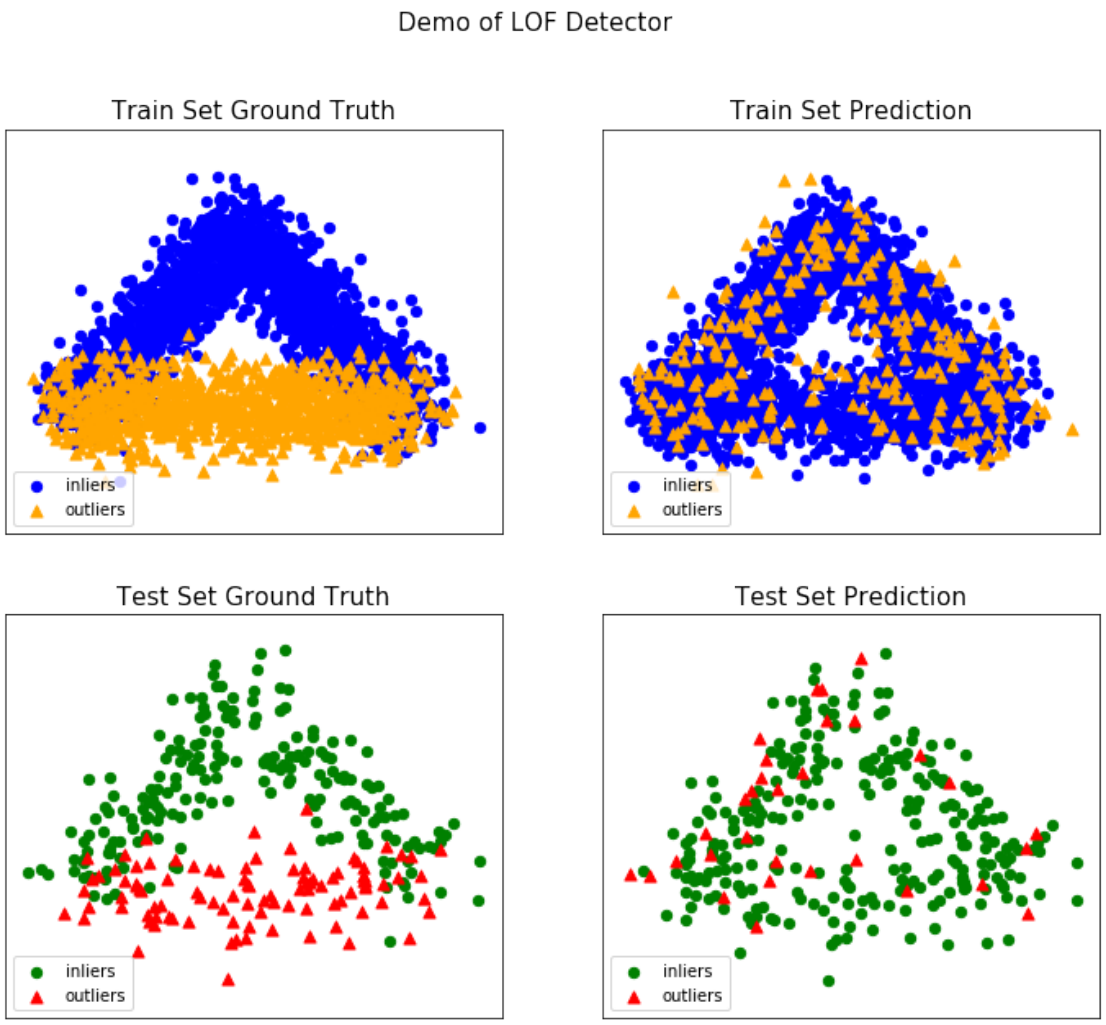
5 使用 LOF 进行异常点分析

5.1 计算 ROC-AUC 分数并可视化

[8]:
```
from pyod.models.lof import LOF

clf = LOF()
# pca = PCA(n_components=2)
# analyse_train_set_feature = pca.fit_transform(train_set_feature)
# pca_test = PCA(n_components=2)
# analyse_test_set_feature = pca_test.fit_transform(test_set_feature)
analyse_train_set_feature = train_set_feature
analyse_test_set_feature = test_set_feature

# clf.fit(train_set_feature)
clf.fit(analyse_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)
y_test_pred = clf.predict(analyse_test_set_feature)
y_test_score = clf.decision_function(analyse_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:0.5311192476677589, precision:0.3381858902575588
Test AUC:0.48469772350369367, precision:0.2828282828282828
```



使用 IOF 算法识别的结果，AUC 在 0.4-0.5 之间，且从降维后的特征图来看，效果并不好，不能很好的把异常点分开。

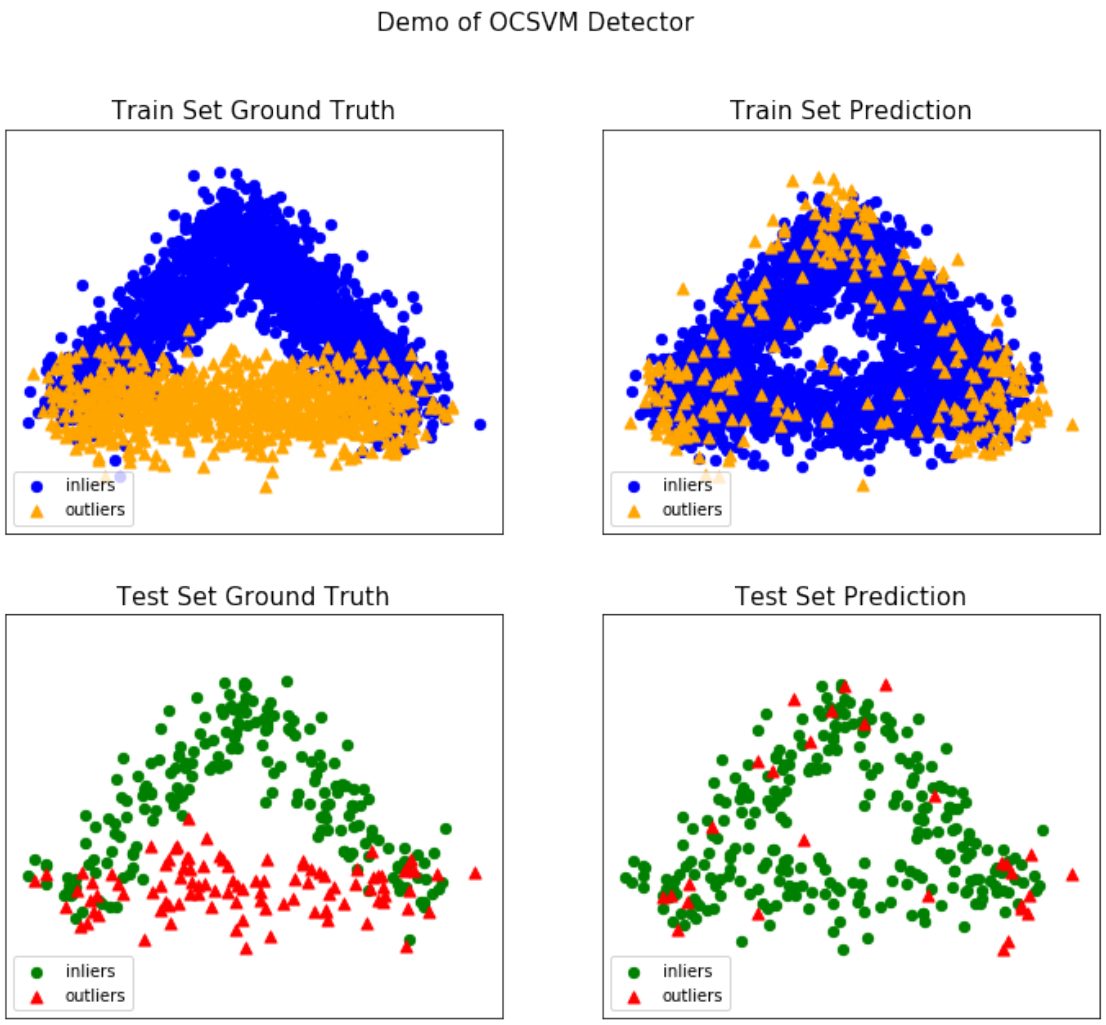
6 使用 OCSVM 进行异常点分析

6.1 计算 ROC-AUC 分数并可视化

[10]:
```
from pyod.models.ocsvm import OCSVM

clf = OCSVM()
# pca = PCA(n_components=2)
# analyse_train_set_feature = pca.fit_transform(train_set_feature)
# pca_test = PCA(n_components=2)
# analyse_test_set_feature = pca_test.fit_transform(test_set_feature)
analyse_train_set_feature = train_set_feature
analyse_test_set_feature = test_set_feature

# clf.fit(train_set_feature)
clf.fit(analyse_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)
y_test_pred = clf.predict(analyse_test_set_feature)
y_test_score = clf.decision_function(analyse_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:0.5178804632865786, precision:0.3303471444568869
Test AUC:0.5454545454545455, precision:0.37373737373737376
```



可以看出 OCSVM 和 IForest 比较类似，只能识别出各个类之间的边界的异常点，对于异常点内部的点，无法做出有效的识别。

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 wave_benchmark_result.csv 中。

[14]:
```
import os
import csv

root_path = 'D:/homework_for_data_mining/outlier detection/wave/benchmarks/'
csv_file_name = 'D:/homework_for_data_mining/outlier detection/wave/
 ↪wave_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, ['V','V.1','V.2','V.
↪3','V.4','V.5','V.6','V.7','V.8','V.9','V.10','V.11','V.12','V.13','V.14','V.
↪15','V.16','V.17','V.18','V.19','V.20']]
    train_set_feature = np.array(train_set_feature.values.tolist())
    test_set_feature = meta_data.loc[test_set_index, ['V','V.1','V.2','V.3','V.
↪4','V.5','V.6','V.7','V.8','V.9','V.10','V.11','V.12','V.13','V.14','V.
↪15','V.16','V.17','V.18','V.19','V.20']]
    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 wave_benchmark_result.csv')
```

wave_benchmark_0001.csv
wave_benchmark_0002.csv
wave_benchmark_0003.csv
wave_benchmark_0004.csv
wave_benchmark_0005.csv
wave_benchmark_0006.csv
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wave_benchmark_0065.csv
wave_benchmark_0066.csv
wave_benchmark_0067.csv
wave_benchmark_0068.csv
wave_benchmark_0069.csv
wave_benchmark_0070.csv
wave_benchmark_0071.csv
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wave_benchmark_0075.csv
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wave_benchmark_0099.csv
wave_benchmark_0100.csv
wave_benchmark_0101.csv
wave_benchmark_0102.csv
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wave_benchmark_0109.csv
wave_benchmark_0110.csv
wave_benchmark_0111.csv

wave_benchmark_0112.csv
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wave_benchmark_0115.csv
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wave_benchmark_0121.csv
wave_benchmark_0122.csv
wave_benchmark_0123.csv
wave_benchmark_0124.csv
wave_benchmark_0125.csv
wave_benchmark_0126.csv
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wave_benchmark_0129.csv
wave_benchmark_0130.csv
wave_benchmark_0131.csv
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wave_benchmark_0145.csv
wave_benchmark_0146.csv
wave_benchmark_0147.csv
wave_benchmark_0148.csv

wave_benchmark_0149.csv
wave_benchmark_0150.csv
wave_benchmark_0151.csv
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wave_benchmark_1634.csv
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wave_benchmark_1636.csv
wave_benchmark_1637.csv
wave_benchmark_1638.csv
wave_benchmark_1639.csv
wave_benchmark_1640.csv
Results are saved in wine_benchmark_result.csv
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