In [3]:

```python
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from time import time
from sklearn.ensemble import IsolationForest
from sklearn.svm import OneClassSVM
from sklearn.neighbors import LocalOutlierFactor
from sklearn.metrics import confusion_matrix
from sklearn.metrics import roc_auc_score
from matplotlib.mlab import frange
import statistics
from sklearn.metrics import confusion_matrix
from sklearn.metrics import precision_score, recall_score
from sklearn.metrics import f1_score
from sklearn.metrics import roc_curve
from imblearn.metrics import specificity_score
from imblearn.metrics import sensitivity_score
```

Using TensorFlow backend.

Chargement du jeu de données Shuttle

Shuttle contient 10 attributs dont le dernier est la classe à expliquer. Il y a 46464 observations dont 878 anormales. Avec le dernier attribut, nous avons les classes "o" pour les anomalies et "n" pour les observations normales.

```
data_brut_Shuttle = pd.read_csv('/Users/thesard/Doctorat/These
2018/ISEP/Developpements/EspaceIntelliJ/LearningAllInPython/Le
arning_IHM_Features/datasets/imported_datasets/shuttle-unsuper
vised-ad_2019-06-14 17:33:02.493755.csv', header=None, index_c
ol=None)
X_Shuttle = data_brut_Shuttle[[0, 1, 2, 3, 4, 5, 6, 7, 8]]
y_brut_Shuttle = data_brut_Shuttle[[9]]
data_brut_Shuttle.describe()
```

Out[4]:

	0	1	2	3	3
count	46464.000000	46464.000000	46464.000000	46464.000000	4646
mean	44.775482	-0.712509	84.834108	0.279291	3
std	8.753404	44.218007	8.731175	37.317203	
min	27.000000	-4475.000000	21.000000	-3939.000000	-18
25%	37.000000	0.000000	79.000000	0.000000	3
50%	43.000000	0.000000	83.000000	0.000000	4
75%	49.000000	0.000000	87.000000	0.000000	4
max	123.000000	1963.000000	149.000000	3830.000000	43

Chargement du jeu de données KDD99-Cup HTTP

KDD99-Cup HTTP contient 30 attributs dont le dernier est la classe à expliquer. Il y a 620098 observations dont 1052 anormales. Avec le dernier attribut, nous avons les classes "o" pour les anomalies et "n" pour les observations normales.

```
data_brut_KDD99CUP = pd.read_csv('/Users/thesard/Doctorat/Thes
e2018/ISEP/Developpements/EspaceIntelliJ/LearningAllInPython/L
earning_IHM_Features/datasets/imported_datasets/kdd99-unsuperv
ised-ad_2019-06-24 16:08:29.815617.csv', header=None, index_co
l=None)
X_KDD99CUP = data_brut_KDD99CUP[[0, 1, 2, 3, 4, 5, 6, 7, 8, 9,
10, 11, 12, 13 ,14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25
, 26, 27, 28]]
y_brut_KDD99CUP = data_brut_KDD99CUP[[29]]
data_brut_KDD99CUP.describe()
```

Out[5]:

	0	1	2	3
count	620098.000000	620098.000000	6.200980e+05	620098.000000
mean	0.627670	280.374673	4.099298e+03	0.005012
std	53.972528	1509.901935	2.369388e+04	0.098271
min	0.000000	0.000000	0.000000e+00	0.000000
25%	0.000000	210.000000	4.580000e+02	0.000000
50%	0.000000	240.000000	1.425000e+03	0.000000
75%	0.000000	302.000000	3.731000e+03	0.000000
max	41065.000000	54540.000000	1.173059e+07	21.000000

8 rows × 29 columns

Transformation de la classe à expliquer

L'objectif ici est de remplacer les "o" par -1 et les "n" par 1 afin de faire les matrices de confusion avec la fonction dédiée de scikit-learn.

```
y_transform_Shuttle = y_brut_Shuttle
y_transform_Shuttle = np.where(y_transform_Shuttle=='o',-1,1)
#y_transform
y_transform_KDD99CUP = y_brut_KDD99CUP
y_transform_KDD99CUP = np.where(y_transform_KDD99CUP=='o',-1,1
)
#y_transform_KDD99CUP
```

Shuttle

Exécution de Isolation Forest sur le jeux de données Shuttle en faisant varier n_estimators

Etude de l'inconstance de IForest

Utilisant les valeurs par défaut des paramètres de IForest au niveau de scikit-learn

```python
study_executions_time_IF_Shuttle = []
study_roc_auc_IF_Shuttle = []
study_recalls_IF_Shuttle = []
study_specificity_IF_Shuttle = []

for j in range(10, 100, 10):
    start_IF_Shuttle = time()

    # Instanciation, fit and predict on Shuttle
    study_func_IF_Shuttle = IsolationForest(behaviour="new")
    study_func_IF_Shuttle.fit(X_Shuttle)
    study_y_pred_IF_Shuttle = study_func_IF_Shuttle.predict(X_
Shuttle)

    # Calcul du temps d'exécution
    study_exec_time_IF_Shuttle = time() - start_IF_Shuttle
    study_executions_time_IF_Shuttle.append(study_exec_time_IF
_Shuttle)

    # Recall
    study_recalls_IF_Shuttle.append(recall_score(y_transform_S
huttle, study_y_pred_IF_Shuttle))

    # Specificity
    study_specificity_IF_Shuttle.append(specificity_score(y_tr
ansform_Shuttle, study_y_pred_IF_Shuttle))

    # Calcul de l'aire sous la courbe ROC
    study_y_DF_IF_Shuttle = study_func_IF_Shuttle.decision_fun
ction(X_Shuttle)
    study_auc_IF_Shuttle = roc_auc_score(y_transform_Shuttle,
study_y_DF_IF_Shuttle)
    study_roc_auc_IF_Shuttle.append(study_auc_IF_Shuttle)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
    FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
    FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
    FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
    FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
    FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
    FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
    FutureWarning)
```

In [14]:

```python
# Evolution de spécificité et rappel
plt.plot(range(10, 100, 10), study_recalls_IF_Shuttle, "g-", label="Rappel")
plt.plot(range(10, 100, 10), study_specificity_IF_Shuttle, "r--", label="Spécificité")
plt.plot(range(10, 100, 10), study_roc_auc_IF_Shuttle, "b--", label="ROC AUC")
plt.plot(range(10, 100, 10), study_executions_time_IF_Shuttle, "y-", label="Temps d'exécution")
plt.title("Courbe Etude de l'inconstance de IForest")
plt.axis([10, 90, 0, 4])
plt.xlabel('Execution Number')
plt.ylabel('Metrics Value')
plt.legend(loc="best")

plt.show()
```
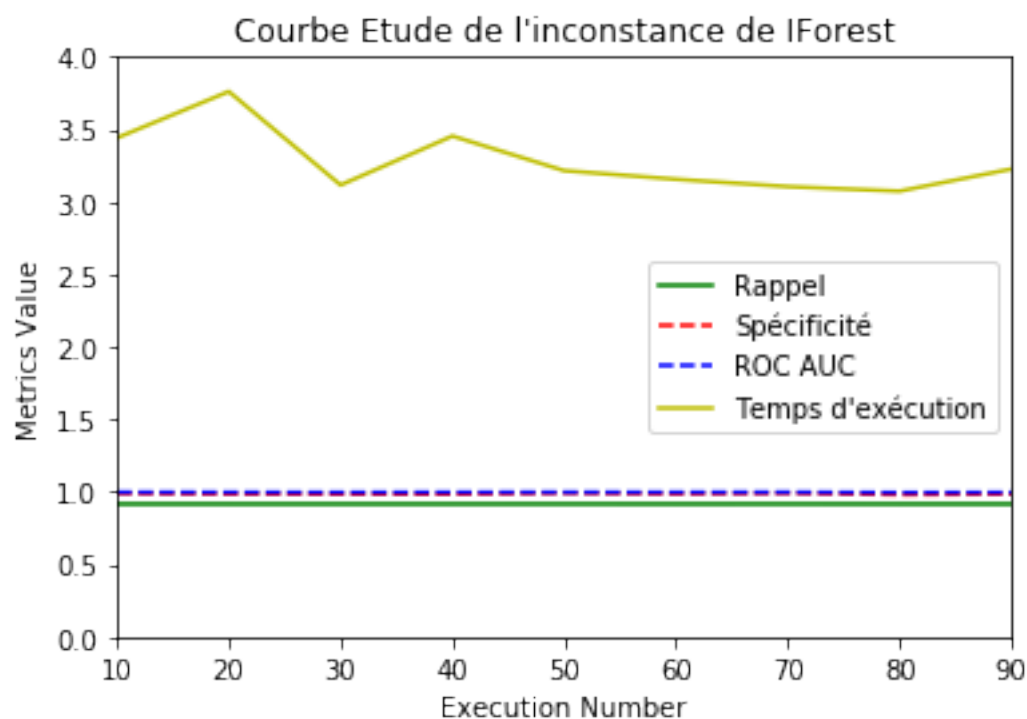

Conclusion

Malgré le caractère aléatoire de IForest, les métrics choisis ont tendance à être constant durant l'exécution successive avec les mêmes paramètres.

In [15]:

```python
executions_time_IF_Shuttle = []
roc_auc_IF_Shuttle = []
precisions_IF_Shuttle = []
```

```python
recalls_IF_Shuttle = []
f1_scores_IF_Shuttle = []
tn_IF_Shuttle = []
fp_IF_Shuttle = []
fn_IF_Shuttle = []
tp_IF_Shuttle = []
specificity_IF_Shuttle = []
n_estimators_IF_Shuttle = []

for j in range(10, 1000, 10):
    print("n_estimators = "+str(j))
    n_estimators = j
    n_estimators_IF_Shuttle.append(j)
    start_IF_Shuttle = time()

    # Instanciation, fit and predict on Shuttle
    func_IF_Shuttle = IsolationForest(n_estimators=n_estimator
s, behaviour="new")
    func_IF_Shuttle.fit(X_Shuttle)
    y_pred_IF_Shuttle = func_IF_Shuttle.predict(X_Shuttle)

    # Calcul du temps d'exécution
    exec_time_IF_Shuttle = time() - start_IF_Shuttle
    executions_time_IF_Shuttle.append(exec_time_IF_Shuttle)

    # Precision
    precisions_IF_Shuttle.append(precision_score(y_transform_S
huttle, y_pred_IF_Shuttle))

    # Recall
    recalls_IF_Shuttle.append(recall_score(y_transform_Shuttle
, y_pred_IF_Shuttle))

    # f1_score
    f1_scores_IF_Shuttle.append(f1_score(y_transform_Shuttle,
y_pred_IF_Shuttle))

    # Specificity
    specificity_IF_Shuttle.append(specificity_score(y_transfor
m_Shuttle, y_pred_IF_Shuttle))

    # Matrice de confusion
    ttn, tfp, tfn, ttp = confusion_matrix(y_transform_Shuttle,
y_pred_IF_Shuttle).ravel()
    tn = ttp
    fp = tfn
    fn = tfp
    tp = ttn
    tn_IF_Shuttle.append(tn)
```

```
    fp_IF_Shuttle.append(fp)

    fn_IF_Shuttle.append(fn)
    tp_IF_Shuttle.append(tp)

    # Calcul de l'aire sous la courbe ROC
    y_DF_IF_Shuttle = func_IF_Shuttle.decision_function(X_Shut
tle)
    auc_IF_Shuttle = roc_auc_score(y_transform_Shuttle, y_DF_I
F_Shuttle)
    roc_auc_IF_Shuttle.append(auc_IF_Shuttle)

    print("Execution time of IsolationForest applied on Shuttl
e (in second)")
    print(executions_time_IF_Shuttle)
    print("ROC AUC for Isolation Forest applied on Shuttle")
    print(roc_auc_IF_Shuttle)
```

```
n_estimators = 10

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637]
n_estimators = 20

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367]
n_estimators = 30
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679]
n_estimators = 40

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016]
n_estimators = 50

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.65032982826232 9]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438]
n_estimators = 60
```

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.9982670367865609]
n_estimators = 70

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.9982670367865609, 0.996889405861029]
n_estimators = 80

```
Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.9982670367865609, 0.996889405861029, 0.996857562
871229]
n_estimators = 90


/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.9982670367865609, 0.996889405861029, 0.996857562
871229, 0.998813427013269]
n_estimators = 100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497]
n_estimators = 110

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.996854852032216]
n_estimators = 120

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.9968548520321, 0.9965284645097947]
n_estimators = 130

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.9968548520321, 0.9965284645097947, 0.9984822049530254]
n_estimators = 140

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.65029828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.18646122102508545]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.99685485203216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412]
n_estimators = 150

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.99685485203216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809]
n_estimators = 170

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.99685485203216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899]
n_estimators = 180

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1864612102508545, 4.44146990776062, 6.19
5428133010864, 5.409062147140503, 5.65195584297180
2]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.9982670367865609, 0.996889405861029, 0.996857562
871229, 0.998813427013269, 0.9975229801700497, 0.9
9685485203216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04]
n_estimators = 190

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.9968545485203216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794]
n_estimators = 200

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.9968545485203216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169]
n_estimators = 210

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1864612102508545, 4.44146990776062, 6.19
5428133010864, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.9982670367865609, 0.996889405861029, 0.996857562
871229, 0.998813427013269, 0.9975229801700497, 0.9
9685485203216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633]
n_estimators = 220

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.99685485203216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392]
n_estimators = 230

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.99685485203216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.997660983115645]
n_estimators = 240

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.9988134270132669, 0.9975229801700497, 0.996854852032216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.997660983115645, 0.9980709569246922]
n_estimators = 250

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.996854852032216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.997660983115645, 0.9980709569246922, 0.9972660375987632]
n_estimators = 260

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.9988134270113269, 0.9975229801700497, 0.9968548520321, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.9976609831156645, 0.9980709569246922, 0.9972660375987632, 0.997785606758739]
n_estimators = 270

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.99685485203216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.997660983115645, 0.9980709569246922, 0.9972660375987632, 0.997785606758739, 0.9967404221433528]
n_estimators = 280

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.9988134270132690, 0.9975229801700497, 0.9968548520321600, 0.9965284645097947, 0.99848220495302540, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.99782298385779040, 0.9976194960347794, 0.9974970835369169, 0.99680530738816330, 0.9968955271105392, 0.99766098311564500, 0.9980709569246922, 0.9972660375987632, 0.997785606758739, 0.9967404221433528, 0.9974054396871037]
n_estimators = 290

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.9533789155786743]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.996854852032516, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.9976609831564 5, 0.9980709569246922, 0.9972660375987632, 0.997785606758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173]
n_estimators = 300

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.99685485203216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.9976609831156455, 0.9980709569246922, 0.9972660375987632, 0.9977856606758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253]
n_estimators = 310

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537, 9.324568033218384]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.996854852032216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.9976609831156445, 0.9980709569246922, 0.9972660375987632, 0.9977856606758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253, 0.9971647871349224]
n_estimators = 320

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537, 9.324568033218384, 9.652966976165771]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.9968548520321, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.997660983115645, 0.9980709569246922, 0.9972660375987632, 0.997785606758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253, 0.9971647871349224, 0.9979909559412948]
n_estimators = 330

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537, 9.324568033218384, 9.652966976165771, 10.455974102020264]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.996854852032216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.99766098311564, 5, 0.9980709569246922, 0.9972660375987632, 0.997785606758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253, 0.9971647871349224, 0.9979909559412948, 0.9976052922374462]
n_estimators = 340

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537, 9.324568033218384, 9.652966976165771, 10.455974102020264, 10.322875261306763]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.99685485203216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.99688955271105392, 0.9976609831156445, 0.9980709569246922, 0.9972660375987632, 0.997785606758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253, 0.9971647871349224, 0.9979909559412948, 0.9976052922374462, 0.9976983102453126]
n_estimators = 350

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1846612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537, 9.324568033218384, 9.652966976165771, 10.455974102020264, 10.322875261306763, 10.52415680885315]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.99685485203216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.9976609831156445, 0.9980709569246922, 0.9972660375987632, 0.997785606758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253, 0.9971647871349224, 0.9979909559412948, 0.9976052922374462, 0.9976983102453126, 0.9973603423182615]
n_estimators = 360

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
  FutureWarning)

```
Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1864612102508545, 4.44146990776062, 6.19
5428133010864, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.166547060012
817, 8.326849937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526
1306763, 10.52415680885315, 10.955713987350464]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.9982670367865609, 0.996889405861029, 0.996857562
871229, 0.998813427013269, 0.9975229801700497, 0.9
9685485203216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.99689552711O5392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429]
n_estimators = 370


/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537, 9.324568033218384, 9.652966976165771, 10.455974102020264, 10.322875261306763, 10.52415680885315, 10.955713987350464, 11.18612813949585]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.9968894058610229, 0.996857562871229, 0.9988134270132669, 0.9975229801700497, 0.996854852032166, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.9976609831156445, 0.9980709569246922, 0.9972660375987632, 0.997785606758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253, 0.9971647871349224, 0.9979909559412948, 0.9976052922374462, 0.9976983102453126, 0.9973603423182615, 0.9977508280676429, 0.9974240532825538]
n_estimators = 380

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537, 9.324568033218384, 9.652966976165771, 10.455974102020264, 10.322875261306763, 10.52415680885315, 10.955713987350464, 11.18612813949585, 12.054737091064453]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.996854852032216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.997660983115645, 0.9980709569246922, 0.9972660375987632, 0.997785606758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253, 0.9971647871349224, 0.9979909559412948, 0.997605292237446, 0.9976983102453126, 0.9973603423182615, 0.9977508280676429, 0.9974240532825538, 0.997471624135892]
n_estimators = 390

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537, 9.324568033218384, 9.652966976165771, 10.455974102020264, 10.322875261306763, 10.52415680885315, 10.955713987350464, 11.18612813949585, 12.054737091064453, 11.90420031547546]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.9968548520321, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.99766098311564, 5, 0.9980709569246922, 0.9972660375987632, 0.9977856606758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253, 0.9971647871349224, 0.9979909559412948, 0.9976052922374462, 0.9976983102453126, 0.9973603423182615, 0.9977508280676429, 0.9974240532825538, 0.997471624135892, 0.9967403721739689]
n_estimators = 400

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537, 9.324568033218384, 9.652966976165771, 10.455974102020264, 10.322875261306763, 10.52415680885315, 10.955713987350464, 11.18612813949585, 12.054737091064453, 11.904200315475464, 12.338850259780884]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.996854852032116, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.9976609831156445, 0.9980709569246922, 0.9972660375987632, 0.9977856606758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253, 0.9971647871349224, 0.9979909559412948, 0.9976052922374462, 0.9976983102453126, 0.9973603423182615, 0.9977508280676429, 0.9974240532825538, 0.997471624135892, 0.9967403721739689, 0.9975277897232365]
n_estimators = 410

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537, 9.324568033218384, 9.652966976165771, 10.455974102020264, 10.322875261306763, 10.52415680885315, 10.955713987350464, 11.18612813949585, 12.054737091064453, 11.904200315475464, 12.338850259780884, 12.52047586441045]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.996854852032116, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.9976609831156445, 0.9980709569246922, 0.9972660375987632, 0.9977856606758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253, 0.9971647871349224, 0.9979909559412948, 0.9976052922374462, 0.9976983102453126, 0.9973603423182615, 0.9977508280676429, 0.9974240532825538, 0.997471624135892, 0.9967403721739689, 0.9975277897232365, 0.9969625860235435]
n_estimators = 420

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537, 9.324568033218384, 9.652966976165771, 10.455974102020264, 10.322875261306763, 10.52415680885315, 10.955713987350464, 11.18612813949585, 12.054737091064453, 11.904200315475464, 12.338850259780884, 12.5204758644104, 12.797037124633789]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.99685485203216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.9976609831156445, 0.9980709569246922, 0.9972660375987632, 0.9977856606758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253, 0.9971647871349224, 0.9979909559412948, 0.9976052922374462, 0.9976983102453126, 0.9973603423182615, 0.9977508280676429, 0.9974240532825538, 0.997471624135892, 0.9967403721739689, 0.9975277897232365, 0.9969625860235435, 0.9971359797851856]
n_estimators = 430

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537, 9.324568033218384, 9.652966976165771, 10.455974102020264, 10.322875261306763, 10.52415680885315, 10.955713987350464, 11.18612813949585, 12.054737091064453, 11.904200315475464, 12.338850259780884, 12.5204758644104, 12.797037124633789, 13.128127098083496]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.99685485203216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.9976609831156445, 0.9980709569246922, 0.9972660375987632, 0.9977856606758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253, 0.9971647871349224, 0.9979909559412948, 0.9976052922374462, 0.9976983102453126, 0.9973603423182615, 0.9977508280676429, 0.9974240532825538, 0.997471624135892, 0.9967403721739689, 0.9975277897232365, 0.9969625860235435, 0.9971359797851856, 0.997482792293162]
n_estimators = 440

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.65032982826232 9, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.18677902216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537, 9.324568033218384, 9.652966976165771, 10.455974102020264, 10.322875261306763, 10.52415680885315, 10.955713987350464, 11.18612813949585, 12.054737091064453, 11.904200315475464, 12.338850259780884, 12.5204758644104, 12.797037124633789, 13.128127098083496, 13.581660032272339]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.9968894058610 29, 0.996857562871229, 0.9988134270132 69, 0.9975229801700497, 0.99685485203216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.99766098311564 5, 0.9980709569246922, 0.9972660375987632, 0.997785606758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253, 0.9971647871349224, 0.9979909559412948, 0.9976052922374462, 0.9976983102453126, 0.9973603423182615, 0.9977508280676429, 0.9974240532825538, 0.997471624135892, 0.9967403721739689, 0.9975277897232365, 0.9969625860235435, 0.9971359797851856, 0.997482792293162, 0.9980933432086161]
n_estimators = 450

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.65029828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1846612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537, 9.324568033218384, 9.652966976165771, 10.455974102020264, 10.322875261306763, 10.52415680885315, 10.955713987350464, 11.18612813949585, 12.054737091064453, 11.90420031547546, 12.338850259780884, 12.5204758644104, 12.797037124633789, 13.128127098083496, 13.581660032272339, 13.837814092636108]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.9968894058611029, 0.996857562871229, 0.9988813427013269, 0.9975229801700497, 0.99685485203216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.997660983115645, 0.9980709569246922, 0.9972660375987632, 0.997785606758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253, 0.9971647871349224, 0.9979909559412948, 0.9976052922374462, 0.9976983102453126, 0.9973603423182615, 0.9977508280676429, 0.9974240532825538, 0.997471624135892, 0.9967403721739689, 0.9975277897232365, 0.9969625860235435, 0.9971359797851856, 0.997482792293162, 0.9980933432086161, 0.997933166348978]
n_estimators = 460

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537, 9.324568033218384, 9.652966976165771, 10.455974102020264, 10.322875261306763, 10.52415680885315, 10.955713987350464, 11.18612813949585, 12.054737091064453, 11.90420031547546, 12.338850259780884, 12.5204758644104, 12.797037124633789, 13.128127098083496, 13.581660032272339, 13.837814092636108, 14.62335991859436]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.9968894058610229, 0.996857562871229, 0.9988134270132690, 0.9975229801700497, 0.99685485203216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.997660983115645, 0.9980709569246922, 0.9972660375987632, 0.997785606758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253, 0.9971647871349224, 0.9979909559412948, 0.9976052922374462, 0.9976983102453126, 0.9973603423182615, 0.9977508280676429, 0.9974240532825538, 0.997471624135892, 0.9967403721739689, 0.9975277897232365, 0.9969625860235435, 0.9971359797851856, 0.997482792293162, 0.9980933432086161, 0.997933166348978, 0.9976543871569888]
n_estimators = 470

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1846612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537, 9.324568033218384, 9.652966976165771, 10.455974102020264, 10.322875261306763, 10.52415680885315, 10.955713987350464, 11.18612813949585, 12.054737091064453, 11.904200315475464, 12.338850259780884, 12.5204758644104, 12.797037124633789, 13.128127098083496, 13.581660032272339, 13.837814092636108, 14.62335991859436, 14.878289699554443]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.99685485203216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.9976609831156456, 0.9980709569246922, 0.9972660375987632, 0.9977856606758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253, 0.9971647871349224, 0.9979909559412948, 0.9976052922374462, 0.9976983102453126, 0.9973603423182615, 0.9977508280676429, 0.9974240532825538, 0.997471624135892, 0.9967403721739689, 0.9975277897232365, 0.9969625860235435, 0.9971359797851856, 0.997482792293162, 0.9980933432086161, 0.997933166348978, 0.9976543871569888, 0.997459606499098]
n_estimators = 480

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537, 9.324568033218384, 9.652966976165771, 10.455974102020264, 10.322875261306763, 10.52415680885315, 10.955713987350464, 11.18612813949585, 12.054737091064453, 11.904200315475464, 12.338850259780884, 12.5204758644104, 12.797037124633789, 13.128127098083496, 13.581660032272339, 13.837814092636108, 14.62335991859436, 14.878289699554443, 15.102436304092407]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.99685485203216, 0.9965284645097947, 0.9984822049530254, 0.99725511928412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.9976609831156445, 0.9980709569246922, 0.9972660375987632, 0.9977856606758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253, 0.9971647871349224, 0.9979909559412948, 0.9976052922374462, 0.9976983102453126, 0.9973603423182615, 0.9977508280676429, 0.9974240532825538, 0.997471624135892, 0.9967403721739689, 0.9975277897232365, 0.9969625860235435, 0.9971359797851856, 0.997482792293162, 0.9980933432086161, 0.997933166348978, 0.9976543871569888, 0.997459606499098, 0.9972750945495694]
n_estimators = 490

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537, 9.324568033218384, 9.652966976165771, 10.455974102020264, 10.322875261306763, 10.52415680885315, 10.955713987350464, 11.18612813949585, 12.054737091064453, 11.904200315475464, 12.338850259780884, 12.5204758644104, 12.797037124633789, 13.128127098083496, 13.581660032272339, 13.837814092636108, 14.62335991859436, 14.878289699554443, 15.102436304092407, 15.223748922348022]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.99685485203216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.997660983115645, 0.9980709569246922, 0.9972660375987632, 0.9977856606758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253, 0.9971647871349224, 0.9979909559412948, 0.9976052922374462, 0.9976983102453126, 0.9973603423182615, 0.9977508280676429, 0.9974240532825538, 0.997471624135892, 0.9967403721739689, 0.9975277897232365, 0.9969625860235435, 0.9971359797851856, 0.997482792293162, 0.9980933432086161, 0.997933166348978, 0.9976543871569888, 0.997459606499098, 0.9972750945495694, 0.9977369115942663]
n_estimators = 500

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537, 9.324568033218384, 9.652966976165771, 10.455974102020264, 10.322875261306763, 10.52415680885315, 10.955713987350464, 11.18612813949585, 12.054737091064453, 11.904200315475464, 12.338850259780884, 12.5204758644104, 12.797037124633789, 13.128127098083496, 13.581660032272339, 13.837814092636108, 14.62335991859436, 14.878289699554443, 15.102436304092407, 15.223748922348022, 15.394045114517212]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.9968548520332166, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.9976609831156456, 0.9980709569246922, 0.9972660375987632, 0.9977856606758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253, 0.9971647871349224, 0.9979909559412948, 0.9976052922374462, 0.9976983102453126, 0.9973603423182615, 0.9977508280676429, 0.9974240532825538, 0.997471624135892, 0.9967403721739689, 0.9975277897232365, 0.9969625860235435, 0.9971359797851856, 0.997482792293162, 0.9980933432086161, 0.997933166348978, 0.9976543871569888, 0.99745960649098, 0.9972750945495694, 0.997369115942663, 0.9979641973362922]
n_estimators = 510

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537, 9.324568033218384, 9.652966976165771, 10.455974102020264, 10.322875261306763, 10.52415680885315, 10.955713987350464, 11.18612813949585, 12.054737091064453, 11.904200315475464, 12.338850259780884, 12.5204758644104, 12.797037124633789, 13.128127098083496, 13.581660032272339, 13.837814092636108, 14.62335991859436, 14.878289699554443, 15.102436304092407, 15.223748922348022, 15.394045114517212, 16.53843402862549]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.996854852032166, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.9976609831156445, 0.9980709569246922, 0.9972660375987632, 0.9977856606758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253, 0.9971647871349224, 0.9979909559412948, 0.9976052922374462, 0.9976983102453126, 0.9973603423182615, 0.9977508280676429, 0.9974240532825538, 0.997471624135892, 0.9967403721739689, 0.9975277897232365, 0.9969625860235435, 0.9971359797851856, 0.997482792293162, 0.9980933432086161, 0.997933166348978, 0.9976543871569888, 0.997459606499098, 0.9972750945495694, 0.977369115942663, 0.9979641973362922, 0.9975246416520598]
n_estimators = 520

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537, 9.324568033218384, 9.652966976165771, 10.455974102020264, 10.322875261306763, 10.52415680885315, 10.955713987350464, 11.18612813949585, 12.054737091064453, 11.904200315475464, 12.338850259780884, 12.5204758644104, 12.797037124633789, 13.128127098083496, 13.581660032272339, 13.837814092636108, 14.62335991859436, 14.878289699554443, 15.102436304092407, 15.223748922348022, 15.394045114517212, 16.53843402862549, 15.700670003890991]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.9968548520321 6, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.997822983857794, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.99766098311564 5, 0.9980709569246922, 0.9972660375987632, 0.99778 5606758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253, 0.9971647871349224, 0.9979909559412948, 0.9976052922374462, 0.9976983102453126, 0.9973603423182615, 0.9977508280676429, 0.9974240532825538, 0.997471624135892, 0.9967403721739689, 0.9975277897232365, 0.996962586 0235435, 0.9971359797851856, 0.997482792293162, 0.9980933432086161, 0.997933166348978, 0.9976543871569888, 0.997459606499098, 0.9972750945495694, 0.997369115942663, 0.9979641973362922, 0.9975246416520598, 0.9971857492914092]
n_estimators = 530

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537, 9.324568033218384, 9.652966976165771, 10.455974102020264, 10.322875261306763, 10.52415680885315, 10.955713987350464, 11.18612813949585, 12.054737091064453, 11.904200315475464, 12.338850259780884, 12.5204758644104, 12.797037124633789, 13.128127098083496, 13.581660032272339, 13.837814092636108, 14.62335991859436, 14.878289699554443, 15.102436304092407, 15.223748922348022, 15.394045114517212, 16.53843402862549, 15.700670003890991, 16.38036823272705]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.9968548520321 6, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.99766098311564 5, 0.9980709569246922, 0.9972660375987632, 0.9977856066758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253, 0.9971647871349224, 0.9979909559412948, 0.9976052922374462, 0.9976983102453126, 0.9973603423182615, 0.9977508280676429, 0.9974240532825538, 0.997471624135892, 0.9967403721739689, 0.9975277897232365, 0.9969625860235435, 0.9971359797851856, 0.997482792293162, 0.9980933432086161, 0.997933166348978, 0.9976543871569888, 0.997459606499098, 0.9972750945495694, 0.9977369115942663, 0.9979641973362922, 0.9975246416520598, 0.9971857492914092, 0.9976005451459891]
n_estimators = 540

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.32649937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537, 9.324568033218384, 9.652966976165771, 10.455974102020264, 10.322875261306763, 10.52415680885315, 10.955713987350464, 11.18612813949585, 12.054737091064453, 11.904200315475464, 12.338850259780884, 12.5204758644104, 12.797037124633789, 13.128127098083496, 13.581660032272339, 13.837814092636108, 14.62335991859436, 14.878289699554443, 15.102436304092407, 15.223748922348022, 15.394045114517212, 16.53843402862549, 15.700670003890991, 16.38036823272705, 17.5802059173584]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.996854852032156, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.9976609831156645, 0.9980709569246922, 0.9972660375987632, 0.9977856006758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253, 0.9971647871349224, 0.9979909559412948, 0.9976052922374462, 0.9976983102453126, 0.9973603423182615, 0.9977508280676429, 0.9974240532825538, 0.997471624135892, 0.9967403721739689, 0.9975277897232365, 0.9969625860235435, 0.9971359797851856, 0.997482792293162, 0.9980933432086161, 0.997933166348978, 0.9976543871569888, 0.997459606499098, 0.9972750945495694, 0.977369115942663, 0.9979641973362922, 0.9975246416520598, 0.9971857492914092, 0.9976005451459891, 0.9977412839153449]
n_estimators = 550

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537, 9.324568033218384, 9.652966976165771, 10.455974102020264, 10.322875261306763, 10.52415680885315, 10.955713987350464, 11.18612813949585, 12.054737091064453, 11.904200315475464, 12.338850259780884, 12.5204758644104, 12.797037124633789, 13.128127098083496, 13.581660032272339, 13.837814092636108, 14.62335991859436, 14.878289699554443, 15.102436304092407, 15.223748922348022, 15.394045114517212, 16.53843402862549, 15.700670003890991, 16.38036823272705, 17.5802059173584, 18.111566066741943]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.9985485203216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.9976609831156445, 0.9980709569246922, 0.9972660375987632, 0.997785606758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253, 0.9971647871349224, 0.9979909559412948, 0.9976052922374462, 0.9976983102453126, 0.9973603423182615, 0.9977508280676429, 0.9974240532825538, 0.997471624135892, 0.9967403721739689, 0.9975277897232365, 0.99696258

60235435, 0.9971359797851856, 0.9974827922931 62, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
977369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457]
n_estimators = 560

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1864612102508545, 4.44146990776062, 6.19
5428133010864, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.166547060012
817, 8.326849937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526
1306763, 10.52415680885315, 10.955713987350464, 11
.18612813949585, 12.054737091064453, 11.9042003154
75464, 12.338850259780884, 12.5204758644104, 12.79
7037124633789, 13.128127098083496, 13.581660032272
339, 13.837814092636108, 14.62335991859436, 14.878
289699554443, 15.102436304092407, 15.2237489223480
22, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.9982670367865609, 0.996889405861029, 0.996857562
871229, 0.998813427013269, 0.9975229801700497, 0.9
9685485203216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.9968955271105392, 0.99766098311564

```
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
973369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873]
n_estimators = 570

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1864612102508545, 4.44146990776062, 6.19
54428133010864, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.166547060012
817, 8.32684937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652969776165771, 10.455974102020264, 10.32287526
1306763, 10.52415680885315, 10.955713987350464, 11
.18612813949585, 12.054737091064453, 11.9042003154
75464, 12.338850259780884, 12.5204758644104, 12.79
7037124633789, 13.128127098083496, 13.581660032272
339, 13.837814092636108, 14.62335991859436, 14.878
289699554443, 15.10436304092407, 15.2237489223480
22, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183, 19.6154582
50045776]
ROC AUC for Isolation Forest applied on Shuttle
```

```
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.9982670367865609, 0.996889405861029, 0.996857562
871229, 0.998813427013269, 0.9975229801700497, 0.9
9685485203216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.9968955271105392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
977369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179]
n_estimators = 580

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1864612102508545, 4.44146990776062, 6.19
54281330108064, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.166547060012
817, 8.326849937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526
1306763, 10.524156808853150, 10.955713987350464, 11
.18612813949585, 12.054737091064453, 11.9042003154
```

75464, 12.338850259780884, 12.5204758644104, 12.79
7037124633789, 13.128127098083496, 13.581660032272
339, 13.837814092636108, 14.62335991859436, 14.878
289699554443, 15.102436304092407, 15.223748922348022, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183, 19.6154582
50045776, 18.156204223632812]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.9982670367865609, 0.996889405861029, 0.996857562
871229, 0.998813427013269, 0.9975229801700497, 0.9
9685485203216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.99565814775528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.9968955271105392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
977369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729]
n_estimators = 590

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.186461210250854, 4.44146990776062, 6.19

5428133010864, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.166547060012
817, 8.326849937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526
1306763, 10.52415680885315, 10.955713987350464, 11
.18612813949585, 12.054737091064453, 11.9042003154
75464, 12.338850259780884, 12.5204758644104, 12.79
7037124633789, 13.128127098083496, 13.581660032272
339, 13.837814092636108, 14.62335991859436, 14.878
289699554443, 15.102436304092407, 15.2237489223480
22, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183, 19.6154582
50045776, 18.156204223632812, 18.76840877532959]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.9982670367865609, 0.996889405861029, 0.996857562
871229, 0.998813427013269, 0.9975229801700497, 0.9
9685485203216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.99689552711105392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
977369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657]
n_estimators = 600

Execution time of IsolationForest applied on Shuttle (in second)
[0.32146689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.1954428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537, 9.324568033218384, 9.652966976165771, 10.455974102020264, 10.322875261306763, 10.52415680885315, 10.955713987350464, 11.18612813949585, 12.054737091064453, 11.90420031475464, 12.338850259780884, 12.5204758644104, 12.797037124633789, 13.128127098083496, 13.581660032272339, 13.837814092636108, 14.62335991859436, 14.878289699554443, 15.102436304092407, 15.223748922348022, 15.394045114517212, 16.53843402862549, 15.700670003890991, 16.38036823272705, 17.5802059173584, 18.111566066741943, 19.351031064987183, 19.61545825045776, 18.156204223632812, 18.76840877532959, 19.425849199295044]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.9968894058610229, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.9968548520321699, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.9976609831156645, 0.9980709569246922, 0.9972660375987632, 0.997785606758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253, 0.9971647871349224, 0.9979909559412948, 0.9976052922374462

, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
977369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204]
n_estimators = 610

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1864612102508545, 4.44146990776062, 6.19
5428133010864, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.166547060012
817, 8.326849937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526
1306763, 10.52415680885315, 10.955713987350464, 11
.18612813949585, 12.054737091064453, 11.9042003154
75464, 12.338850259780884, 12.5204758644104, 12.79
7037124633789, 13.128127098083496, 13.581660032272
339, 13.837814092636108, 14.62335991859436, 14.878
289699554443, 15.102436304092407, 15.2237489223480
22, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183, 19.6154582
50045776, 18.156204223632812, 18.76840877532959, 1
9.425849199295044, 21.50138211250305]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,

0.99826703867865609, 0.996889405861029, 0.996857562
871229, 0.998813427013269, 0.9975229801700497, 0.9
96854852032116, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.9968955271105392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
973369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163]
n_estimators = 620

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1864612102508545, 4.44146990776062, 6.19
54281330108864, 5.409062147140503, 5.65195584297180
2, 6.24260045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.166547060012
817, 8.326849937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526
1306763, 10.524156808853115, 10.955713987350464, 11
.18612813949585, 12.054737091064453, 11.9042003154

75464, 12.338850259780884, 12.5204758644104, 12.79
7037124633789, 13.128127098083496, 13.581660032272
339, 13.837814092636108, 14.62335991859436, 14.878
289699554443, 15.10436304092407, 15.2237489223480
22, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183, 19.6154582
50045776, 18.156204223632812, 18.76840877532959, 1
9.425849199295044, 21.50138211250305, 22.101943016
052246]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.9982670367865609, 0.996889405861029, 0.996857562
871229, 0.998813427013269, 0.9975229801700497, 0.9
9685485203216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.9968955271105392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
977369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959]
n_estimators = 630

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.65032982862329,

1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1864612102508545, 4.44146990776062, 6.19
54428133010864, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.166547060012
817, 8.326849937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652969976165771, 10.455974102020264, 10.32287526
1306763, 10.52415680885315, 10.955713987350464, 11
.18612813949585, 12.054737091064453, 11.9042003154
75464, 12.338850259780884, 12.5204758644104, 12.79
7037124633789, 13.128127098083496, 13.581660032272
339, 13.837814092636108, 14.62335991859436, 14.878
289699554443, 15.102436304092407, 15.2237489223480
22, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183, 19.6154582
50045776, 18.156204223632812, 18.76840877532959, 1
9.425849199295044, 21.50138211250305, 22.101943016
052246, 23.14012598991394]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.9982670367865609, 0.9968894058610.29, 0.996857562
871229, 0.998813427013269, 0.9975229801700497, 0.9
9685485203216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.9968955271105392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
977369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439

00163, 0.9973996182538959, 0.9977952508498044]
n_estimators = 640

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1864612102508545, 4.44146990776062, 6.19
54281330108664, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.166547060012
817, 8.326849937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526
1306763, 10.52415680885315, 10.955713987350464, 11
.18612813949585, 12.054737091064453, 11.9042003154
75464, 12.338850259780884, 12.5204758644104, 12.79
7037124633789, 13.128127098083496, 13.581660032272
339, 13.837814092636108, 14.62335991859436, 14.878
289699554443, 15.102436304092407, 15.223748922348022, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183, 19.6154582
50045776, 18.156204223632812, 18.76840877532959, 1
9.425849199295044, 21.50138211250305, 22.101943016
052246, 23.14012598991394, 20.03169584274292]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.9982670367865609, 0.996889405861029, 0.996857562
871229, 0.9988813427013269, 0.9975229801700497, 0.9
9685485203216, 0.9965284645097947, 0.9984822049530
254, 0.99725511928412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.9968955271105392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037

, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.9974827922931 62, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
973369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9979952508498044, 0.9
975368091970049]
n_estimators = 650

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1864612102508545, 4.44146990776062, 6.19
54428133010864, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.166547060012
817, 8.326849937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526
1306763, 10.52415680885315, 10.955713987350464, 11
.18612813949585, 12.054737091064453, 11.9042003154
75464, 12.338850259780884, 12.52204758644104, 12.79
7037124633789, 13.128127098083496, 13.581660032272
339, 13.837814092636108, 14.62335991859436, 14.878
289699554443, 15.102436304092407, 15.223749223480
22, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183, 19.6154582
50045776, 18.156204223632812, 18.76840877532959, 1

9.425849199295044, 21.50138211250305, 22.101943016
052246, 23.14012598991394, 20.03169584274292, 22.0
84593296051025]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.998270367865609, 0.996889405861029, 0.996857562
871229, 0.998813427013269, 0.9975229801700497, 0.9
9685485203216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.9968955271105392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
977369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9977952508498044, 0.9
975368091970049, 0.99752584091727]
n_estimators = 660

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.253798217773438, 1.65032982826232 9,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.70238208770075195, 3.876016139
984131, 4.186412102508545, 4.44146990776062, 6.19
54281330 10864, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711

13204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.165547060012817, 8.326849937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537, 9.324568033218384, 9.652966976165771, 10.455974102020264, 10.322875261306763, 10.52415680885315, 10.955713987350464, 11.18612813949585, 12.054737091064453, 11.904200315475464, 12.338850259780884, 12.5204758644104, 12.797037124633789, 13.128127098083496, 13.581660032272339, 13.837814092636108, 14.62335991859436, 14.878289699554443, 15.102436304092407, 15.223748922348022, 15.394045114517212, 16.53843402862549, 15.700670003890991, 16.38036823272705, 17.5802059173584, 18.111566066741943, 19.351031064987183, 19.615458250045776, 18.156204223632812, 18.76840877532959, 19.425849199295044, 21.50138211250305, 22.101943016052246, 23.14012598991394, 20.03169584274292, 22.084593296051025, 21.982842206954956]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.9968894058861029, 0.996857562871229, 0.9988134270113269, 0.9975229801700497, 0.996854852032216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.996853073881633, 0.9968955271105392, 0.9976609831156445, 0.9980709569246922, 0.9972660375987632, 0.9977856606758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253, 0.9971647871349224, 0.9979909559412948, 0.9976052922374462, 0.9976983102453126, 0.9973603423182615, 0.9977508280676429, 0.9974240532825538, 0.997471624135892, 0.9967403721739689, 0.9975277897232365, 0.9969625860235435, 0.9971359797851856, 0.997482792293162, 0.9980933432086161, 0.997933166348978, 0.9976543871569888, 0.997459606499098, 0.9972750945495694, 0.9977369115942663, 0.9979641973362922, 0.9975246416520598, 0.9971857492914092, 0.9976005451459891, 0.9977412839153449, 0.9975151474691457, 0.9975504008693873, 0.9976773730735179, 0.9976221319197729, 0.9973627908180657, 0.9977902788961204, 0.9976752243900163, 0.9973996182538959, 0.9977952508498044, 0.9975368091970049, 0.99752584091727, 0.9973335337438751]
n_estimators = 670

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537, 9.324568033218384, 9.652966976165771, 10.455974102020264, 10.322875261306763, 10.52415680885315, 10.955713987350464, 11.18612813949585, 12.054737091064453, 11.904200315475464, 12.338850259780884, 12.5204758644104, 12.797037124633789, 13.128127098083496, 13.581660032272339, 13.837814092636108, 14.62335991859436, 14.878289699554443, 15.102436304092407, 15.223748922348022, 15.394045114517212, 16.53843402862549, 15.700670003890991, 16.38036823272705, 17.5802059173584, 18.111566066741943, 19.351031064987183, 19.61545825045776, 18.156204223632812, 18.76840877532959, 19.425849199295044, 21.50138211250305, 22.101943016052246, 23.14012598991394, 20.03169584274292, 22.084593296051025, 21.982842206954956, 20.499260902404785]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.9685485203216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.997660983115645, 0.9980709569246922, 0.9972660375987632, 0.997785606758739, 0.9967404221433528, 0.9974054396871037

```
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
973369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9977952508498044, 0.9
975368091970049, 0.99752584091727, 0.9973335337438
751, 0.9973393052076993]
n_estimators = 680

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1864612102508545, 4.44146990776062, 6.19
5428133010864, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.166547060012
817, 8.326849937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526
1306763, 10.52415680885315, 10.955713987350464, 11
.18612813949585, 12.054737091064453, 11.9042003154
75464, 12.338850259780884, 12.5204758644104, 12.79
7037124633789, 13.128127098083496, 13.581660032272
339, 13.837814092636108, 14.62335991859436, 14.878
289699554443, 15.10436304092407, 15.2237489223480
22, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183, 19.6154582
```

50045776, 18.156204223632812, 18.76840877532959, 1
9.425849199295044, 21.50138211250305, 22.101943016
052246, 23.14012598991394, 20.03169584274292, 22.0
84593296051025, 21.982842206954956, 20.49926090240
4785, 20.61261296272278]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979669438,
0.9982670367865609, 0.9968889405861029, 0.996857562
871229, 0.9988813427013269, 0.9975229801700497, 0.9
9685485203216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.9968955271105392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
977369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9977952508498044, 0.9
975368091970049, 0.99752584091727, 0.9973335337438
751, 0.9973393052076993, 0.9974346717766025]
n_estimators = 690

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.183699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139

984131, 4.18646121025085545, 4.44146990776062, 6.19
5428133010864, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
85784006118744, 8.300517082214355, 8.166547060012
817, 8.326849937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526
1306763, 10.52415680885315, 10.955713987350464, 11
.18612813949585, 12.054737091064453, 11.9042003154
75464, 12.338850259780884, 12.5204758644104, 12.79
7037124633789, 13.128127098083496, 13.581660032272
339, 13.837814092636108, 14.62335991859436, 14.878
289699554443, 15.104363004092407, 15.2237489223480
22, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183, 19.6154582
50045776, 18.156204223632812, 18.76840877532959, 1
9.425849199295044, 21.50138211250305, 22.101943016
052246, 23.14012598991394, 20.03169584274292, 22.0
84593296051025, 21.982842206954956, 20.49926090240
4785, 20.61261296272278, 20.809021234512331]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.9982670367865609, 0.996889405861029, 0.996857562
871229, 0.998813427013269, 0.9975229801700497, 0.9
9685485203216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.99689552711055392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
973369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9977952508498044, 0.9

975368091970049, 0.99752584091727, 0.9973335337438
751, 0.9973393052076993, 0.9974346717766025, 0.997
59973970748122]
n_estimators = 700

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1846412102508545, 4.44146990776062, 6.19
5428133010864, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.166547060012
817, 8.326849937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526
1306763, 10.52415680885315, 10.955713987350464, 11
.18612813949585, 12.054737091064453, 11.9042003154
75464, 12.338850259780884, 12.5204758644104, 12.79
7037124633789, 13.128127098083496, 13.581660032272
339, 13.837814092636108, 14.62335991859436, 14.878
289699554443, 15.102436304092407, 15.2237489223480
22, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183, 19.6154582
50045776, 18.156204223632812, 18.76840877532959, 1
9.425849199295044, 21.50138211250305, 22.101943016
052246, 23.14012598991394, 20.03169584274292, 22.0
84593296051025, 21.982842206954956, 20.49926090240
4785, 20.61261296272278, 20.80902123451233, 21.422
63889312744]
ROC AUC for Isolation Forest applied on Shuttle
[0.99595223006863, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.9982670367865609, 0.9968894058611029, 0.996857562
871229, 0.998813427013269, 0.9975229801700497, 0.9
9685485203216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971

667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.9968955271105392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
973369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9977952508498044, 0.9
975368091970049, 0.99752584091727, 0.9973335337438
751, 0.9973393052076993, 0.9974346717766025, 0.997
5973970748122, 0.9978567131918273]
n_estimators = 710

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1864612102508545, 4.44146990776062, 6.19
54281330108864, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.166547060012
817, 8.32649937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526
1306763, 10.52415680885315, 10.955713987350464, 11
.18612813949585, 12.054737091064453, 11.9042003154
75464, 12.338850259780884, 12.5204758644104, 12.79

7037124633789, 13.128127098083496, 13.581660032272
339, 13.837814092636108, 14.62335991859436, 14.878
289699554443, 15.10243630409207, 15.2237489223480
22, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183, 19.6154582
50045776, 18.156204223632812, 18.76840877532959, 1
9.425849199295044, 21.50138211250305, 22.101943016
052246, 23.14012598991394, 20.03169584274292, 22.0
84593296051025, 21.982842206954956, 20.49926090240
4785, 20.61261296272278, 20.80902123451233, 21.422
63889312744, 23.935853719711304]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.9982670367865609, 0.996889405861029, 0.996857562
871229, 0.998813427013269, 0.9975229801700497, 0.9
9685485203216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.9968955271105392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
977369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9977952508498044, 0.9
975368091970049, 0.99752584091727, 0.9973335337438
751, 0.9973393052076993, 0.9974346717766025, 0.997
5973970748122, 0.9978567131918273, 0.9977493040014
384]
n_estimators = 720

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.19542813010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537, 9.324568033218384, 9.652966976165771, 10.455974102020264, 10.322875261306763, 10.52415680885315, 10.955713987350464, 11.18612813949585, 12.054737091064453, 11.904200315475464, 12.338850259780884, 12.5204758644104, 12.797037124633789, 13.128127098083496, 13.581660032272339, 13.837814092636108, 14.62335991859436, 14.878289699554443, 15.102436304092407, 15.223748922348022, 15.394045114517212, 16.53843402862549, 15.700670003890991, 16.38036823272705, 17.5802059173584, 18.111566066741943, 19.351031064987183, 19.615458250045776, 18.156204223632812, 18.76840877532959, 19.425849199295044, 21.50138211250305, 22.101943016052246, 23.14012598991394, 20.03169584274292, 22.084593296051025, 21.982842206954956, 20.499260902404785, 20.61261296272278, 20.80902123451233, 21.42263889312744, 23.935853719711304, 27.92972707748413
]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189977699438, 0.9982670367865609, 0.9968894058610299, 0.996857562871229, 0.9988134270132699, 0.9975229801700497, 0.9685485203216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968

053073881633, 0.9968955271105392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
977369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9977952508498044, 0.9
975368091970049, 0.99752584091727, 0.9973335337438
751, 0.9973393052076993, 0.9974346717766025, 0.997
5973970748122, 0.9978567131918273, 0.9977493040014
384, 0.9972196535182893]
n_estimators = 730

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1864612102508545, 4.44146990776062, 6.19
5428133010864, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.166547060012
817, 8.326849937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526
1306763, 10.524156808853315, 10.955713987350464, 11
.18612813949585, 12.054737091064453, 11.9042003154
75464, 12.338850259780884, 12.5204758644104, 12.79
7037124633789, 13.128127098083496, 13.581660032272

339, 13.837814092636108, 14.62335991859436, 14.878289699554443, 15.102436304092407, 15.223748922348022, 15.394045114517212, 16.53843402862549, 15.700670003890991, 16.38036823272705, 17.5802059173584, 18.111566066741943, 19.351031064987183, 19.615458250045776, 18.156204223632812, 18.76840877532959, 19.425849199295044, 21.50138211250305, 22.101943016052246, 23.14012598991394, 20.03169584274292, 22.084593296051025, 21.982842206954956, 20.499260902404785, 20.61261296272278, 20.80902123451233, 21.42263889312744, 23.935853719711304, 27.92972707748413, 24.841004848480225]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.99685485203216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.997660983115645, 0.9980709569246922, 0.9972660375987632, 0.997785606758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253, 0.9971647871349224, 0.9979909559412948, 0.9976052922374462, 0.9976983102453126, 0.9973603423182615, 0.9977508280676429, 0.9974240532825538, 0.997471624135892, 0.9967403721739689, 0.9975277897232365, 0.9969625860235435, 0.9971359797851856, 0.997482792293162, 0.9980933432086161, 0.997933166348978, 0.9976543871569888, 0.997459606499098, 0.9972750945495694, 0.9977369115942663, 0.9979641973362922, 0.9975246416520598, 0.9971857492914092, 0.9976005451459891, 0.9977412839153449, 0.9975151474691457, 0.9975504008693873, 0.9976773730735179, 0.9976221319197729, 0.9973627908180657, 0.9977902788961204, 0.9976752243900163, 0.9973996182538959, 0.9977952508498044, 0.9975368091970049, 0.99752584091727, 0.9973335337438751, 0.9973393052076993, 0.9974346717766025, 0.9975973970748122, 0.9978567131918273, 0.9977493040014384, 0.9972196535182893, 0.9978918166839178]
n_estimators = 740

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.6519558429718002, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.9533789157867743, 9.236344814300537, 9.324568033218384, 9.652966976165771, 10.455974102020264, 10.322875261306763, 10.52415680885315, 10.955713987350464, 11.18612813949585, 12.054737091064453, 11.90420031547546, 12.338850259780884, 12.5204758644104, 12.7970371246337895, 13.128127098083496, 13.581660032272339, 13.837814092636108, 14.62335991859436, 14.878289699554443, 15.102436304092407, 15.223748922348022, 15.394045114517212, 16.53843402862549, 15.700670003890991, 16.38036823272705, 17.5802059173584, 18.111566066741943, 19.351031064987183, 19.615458250045776, 18.156204223632812, 18.76840877532959, 19.425849199295044, 21.50138211250305, 22.101943016052246, 23.14012598991394, 20.03169584274292, 22.084593296051025, 21.982842206954956, 20.499260902404785, 20.61261296272278, 20.80902123451233, 21.42263889312744, 23.935853719711304, 27.92972707748413, 24.841004848480225, 23.48153781890869]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189977699438, 0.9982670367865609, 0.9968894058610299, 0.996857562871229, 0.9988134270132699, 0.9975229801700497, 0.9685485203216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968

053073881633, 0.9968955271105392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
977369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9977952508498044, 0.9
975368091970049, 0.99752584091727, 0.9973335337438
751, 0.9973393052076993, 0.9974346717766025, 0.997
5973970748122, 0.9978567131918273, 0.9977493040014
384, 0.9972196535182893, 0.9978918166839178, 0.997
3982440958424]
n_estimators = 750

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1864612102508545, 4.44146990776062, 6.19
54281330108864, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.166547060012
817, 8.32649937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526
1306763, 10.52415680885315, 10.955713987350464, 11
.18612813949585, 12.05473709106453, 11.9042003154
75464, 12.338850259780884, 12.5204758644104, 12.79

7037124633789, 13.128127098083496, 13.581660032272
339, 13.837814092636108, 14.62335991859436, 14.878
289699554443, 15.102436304092407, 15.2237489223480
22, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183, 19.6154582
50045776, 18.156204223632812, 18.76840877532959, 1
9.425849199295044, 21.50138211250305, 22.101943016
052246, 23.14012598991394, 20.03169584274292, 22.0
84593296051025, 21.982842206954956, 20.49926090240
4785, 20.61261296272278, 20.80902123451233, 21.422
63889312744, 23.935853719711304, 27.92972707748413
, 24.841004848480225, 23.48153781890869, 23.012959
957122803]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.9982670367865609, 0.996889405861029, 0.996857562
871229, 0.9988134270132269, 0.9975229801700497, 0.9
9685485203216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.99689552711105392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
973369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9977952508498044, 0.9
975368091970049, 0.99752584091727, 0.9973335337438
751, 0.9973393052076993, 0.9974346717766025, 0.997
5973970748122, 0.9978567131918273, 0.9977493040014
384, 0.9972196535182893, 0.9978918166839178, 0.997
3982440958424, 0.9973941466063743]
n_estimators = 760

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.1954281330108644, 5.409062147140503, 5.6519558429718062, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.9533789155786743, 9.236344814300537, 9.324568033218384, 9.652966976165771, 10.455974102020264, 10.322875261306763, 10.52415680885315, 10.955713987350464, 11.18612813949585, 12.054737091064453, 11.904200315475464, 12.338850259780884, 12.5204758644104, 12.797037124633789, 13.128127098083496, 13.581660032272339, 13.837814092636108, 14.62335991859436, 14.878289699554443, 15.102436304092407, 15.223748922348022, 15.394045114517212, 16.53843402862549, 15.700670003890991, 16.38036823272705, 17.5802059173584, 18.111566066741943, 19.351031064987183, 19.615458250045776, 18.156204223632812, 18.76840877532959, 19.425849199295044, 21.50138211250305, 22.101943016052246, 23.14012598991394, 20.03169584274292, 22.084593296051025, 21.982842206954956, 20.499260902404785, 20.61261296272278, 20.80902123451233, 21.42263889312744, 23.935853719711304, 27.92972707748413, 24.841004848480225, 23.48153781890869, 23.012959957122803, 23.671861171722412]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.99688940586029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.9968545485203216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.99782298385779

04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.9968955271105392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
977369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9977952508498044, 0.9
975368091970049, 0.99752584091727, 0.9973335337438
751, 0.9973393052076993, 0.9974346717766025, 0.997
5973970748122, 0.9978567131918273, 0.9977493040014
384, 0.9972196535182893, 0.9978918166839178, 0.997
3982440958424, 0.9973941466063743, 0.9972725960803
815]
n_estimators = 770

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1846612102508545, 4.44146990776062, 6.19
54281330108640, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.79052813796997, 7.
85784006118744, 8.300517082214355, 8.1665470600012
817, 8.326849937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526
1306763, 10.524156808853150, 10.955713987350464, 11

.18612813949585, 12.054737091064453, 11.9042003154
75464, 12.338850259780884, 12.5204758644104, 12.79
7037124633789, 13.128127098083496, 13.581660032272
339, 13.837814092636108, 14.62335991859436, 14.878
289699554443, 15.102436304092407, 15.2237489223480
22, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183, 19.6154582
50045776, 18.156204223632812, 18.76840877532959, 1
9.425849199295044, 21.50138211250305, 22.101943016
052246, 23.14012598991394, 20.03169584274292, 22.0
84593296051025, 21.982842206954956, 20.49926090240
4785, 20.61261296272278, 20.80902123451233, 21.422
63889312744, 23.935853719711304, 27.92972707748413
, 24.841004848480225, 23.48153781890869, 23.012959
957122803, 23.671861171722412, 26.680218935012817]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.9982670367865609, 0.996889405861029, 0.996857562
871229, 0.9988134270132269, 0.9975229801700497, 0.9
96854852203216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.9968955271105392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
977369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9977952508498044, 0.9
975368091970049, 0.99752584091727, 0.9973335337438
751, 0.9973393052076993, 0.9974346717766025, 0.997
5973970748122, 0.9978567131918273, 0.9977493040014
384, 0.9972196535182893, 0.9978918166839178, 0.997
3982440958424, 0.9973941466063743, 0.9972725960803
815, 0.997860685757836]

```
n_estimators = 780

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.18646121025085545, 4.44146990776062, 6.19
5428133010864, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.166547060012
817, 8.326849937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526
1306763, 10.52415680885315, 10.955713987350464, 11
.18612813949585, 12.054737091064453, 11.9042003154
75464, 12.338850259780884, 12.5204758644104, 12.79
7037124633789, 13.128127098083496, 13.581660032272
339, 13.837814092636108, 14.62335991859436, 14.878
289699554443, 15.102436304092407, 15.2237489223480
22, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183, 19.6154582
50045776, 18.156204223632812, 18.76840877532959, 1
9.425849199295044, 21.50138211250305, 22.101943016
052246, 23.14012598991394, 20.03169584274292, 22.0
84593296051025, 21.982842206954956, 20.49926090240
4785, 20.612612962722788, 20.80902123451233, 21.422
63889312744, 23.935853719711304, 27.92972707748413
, 24.841004848480225, 23.48153781890869, 23.012959
957122803, 23.671861171722412, 26.680218935012817,
24.52654004096985]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.9982670367865609, 0.996889405861029, 0.996857562
871229, 0.998813427013269, 0.9975229801700497, 0.9
9685485203216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
```

667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.99689552711 05392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.997605292237 4462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
973369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9977952508498044, 0.9
975368091970049, 0.99752584091727, 0.9973335337438
751, 0.9973393052076993, 0.9974346717766025, 0.997
5973970748122, 0.9978567131918273, 0.9977493040014
384, 0.9972196535182893, 0.9978918166839178, 0.997
3982440958424, 0.9973941466063743, 0.9972725960803
815, 0.997860685757836, 0.9971477725597525]
n_estimators = 790

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1846612102508545, 4.44146990776062, 6.19
54281330 10864, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.1665470600 12
817, 8.32684993743 8965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526

1306763, 10.524156880885315, 10.955713987350464, 11.18612813949585, 12.054737091064453, 11.904200315475464, 12.338850259780884, 12.5204758644104, 12.797037124633789, 13.128127098083496, 13.581660032272339, 13.837814092636108, 14.62335991859436, 14.878289699554443, 15.102436304092407, 15.223748922348022, 15.394045114517212, 16.53843402862549, 15.700670003890991, 16.38036823272705, 17.5802059173584, 18.111566066741943, 19.351031064987183, 19.615458250045776, 18.156204223632812, 18.76840877532959, 19.425849199295044, 21.50138211250305, 22.101943016052246, 23.14012598991394, 20.03169584274292, 22.084593296051025, 21.982842206954956, 20.499260902404785, 20.61261296272278, 20.80902123451233, 21.42263889312744, 23.935853719711304, 27.92972707748413, 24.84100848480225, 23.48153781890869, 23.012959957122803, 23.671861171722412, 26.680218935012817, 24.52654004096985, 29.90683078765869]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.9988134270132669, 0.9975229801700497, 0.996854852203216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.9976609831156445, 0.9980709569246922, 0.9972660375987632, 0.997785606758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253, 0.9971647871349224, 0.9979909559412948, 0.9976052922374462, 0.9976983102453126, 0.9973603423182615, 0.9977508280676429, 0.9974240532825538, 0.997471624135892, 0.9967403721739689, 0.9975277897232365, 0.9969625860235435, 0.9971359797851856, 0.997482792293162, 0.9980933432086161, 0.997933166348978, 0.9976543871569888, 0.997459606499098, 0.9972750945495694, 0.9973369115942663, 0.9979641973362922, 0.9975246416520598, 0.9971857492914092, 0.9976005451459891, 0.9977412839153449, 0.9975151474691457, 0.997550400869873, 0.9976773730735179, 0.9976221319197729, 0.9973627908180657, 0.9977902788961204, 0.9976752243900163, 0.9973996182538959, 0.9977952508498044, 0.9975368091970049, 0.99752584091727, 0.9973335337438751, 0.9973393052076993, 0.9974346717766025, 0.9975973970748122, 0.9978567131918273, 0.9977493040014384, 0.9972196535182893, 0.9978918166839178, 0.997

3982440958424, 0.9973941466063743, 0.9972725960803
815, 0.997860685757836, 0.9971477725597525, 0.9976
895905878467]
n_estimators = 800

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1864612102508545, 4.44146990776062, 6.19
54281330108664, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.166547060012
817, 8.326849937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526
1306763, 10.52415680885315, 10.955713987350464, 11
.18612813949585, 12.054737091064453, 11.9042003154
75464, 12.338850259780884, 12.5204758644104, 12.79
7037124633789, 13.128127098083496, 13.581660032272
339, 13.837814092636108, 14.62335991859436, 14.878
289699554443, 15.102436304092407, 15.2237489223480
22, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183, 19.6154582
50045776, 18.156204223632812, 18.76840877532959, 1
9.425849199295044, 21.50138211250305, 22.101943016
052246, 23.14012598991394, 20.03169584274292, 22.0
84593296051025, 21.982842206954956, 20.49926090240
4785, 20.61261296272278, 20.80902123451233, 21.422
63889312744, 23.935853719711304, 27.92972707748413
, 24.841004848480225, 23.48153781890869, 23.012959
957122803, 23.671861171722412, 26.680218935012817,
24.52654004096985, 29.90683078765869, 29.034919977
18811]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,

0.99826703678656609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.9685485203216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.99766098311564 5, 0.9980709569246922, 0.9972660375987632, 0.997785606758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253, 0.9971647871349224, 0.9979909559412948, 0.9976052922374462, 0.9976983102453126, 0.9973603423182615, 0.9977508280676429, 0.9974240532825538, 0.997471624135892, 0.9967403721739689, 0.9975277897232365, 0.9969625860235435, 0.9971359797851856, 0.997482792293162, 0.9980933432086161, 0.997933166348978, 0.9976543871569888, 0.997459606499098, 0.9972750945495694, 0.9973369115942663, 0.9979641973362922, 0.9975246416520598, 0.9971857492914092, 0.9976005451459891, 0.9977412839153449, 0.9975151474691457, 0.9975504008693873, 0.9976773730735179, 0.9976221319197729, 0.9973627908180657, 0.9977902788961204, 0.9976752243900163, 0.9973996182538959, 0.9977952508498044, 0.9975368091970049, 0.99752584091727, 0.9973335337438751, 0.9973393052076993, 0.9974346717766025, 0.9975973970748122, 0.9978567131918273, 0.9977493040014384, 0.9972196535182893, 0.9978918166839178, 0.9973982440958424, 0.9973941466063743, 0.9972725960803815, 0.997860685757836, 0.9971477725597525, 0.9976895905878467, 0.997655411529356]
n_estimators = 810

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[0.32146895599936523, 0.6461000442504883, 1.0567457675933838, 1.253798217773438, 1.65029828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.186461210250854, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.2426004562379, 7.220815896987915, 6.7274711

13204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.165547060012817, 8.326849937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537, 9.324568033218384, 9.652966976165771, 10.455974102020264, 10.322875261306763, 10.52415680885315, 10.955713987350464, 11.18612813949585, 12.054737091064453, 11.904200315475464, 12.338850259780884, 12.5204758644104, 12.797037124633789, 13.128127098083496, 13.581660032272339, 13.837814092636108, 14.62335991859436, 14.878289699554443, 15.102436304092407, 15.223748922348022, 15.394045114517212, 16.53843402862549, 15.700670003890991, 16.38036823272705, 17.5802059173584, 18.111566066741943, 19.351031064987183, 19.615458250045776, 18.156204223632812, 18.76840877532959, 19.425849199295044, 21.50138211250305, 22.101943016052246, 23.14012598991394, 20.03169584274292, 22.084593296051025, 21.982842206954956, 20.499260902404785, 20.61261296272278, 20.80902123451233, 21.42263889312744, 23.935853719711304, 27.92972707748413, 24.841004848480225, 23.48153781890869, 23.012959957122803, 23.671861171722412, 26.680218935012817, 24.52654004096985, 29.90683078765869, 29.03491997718811, 26.721741914749146]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.9968548520321 6, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.9976609831156 45, 0.9980709569246922, 0.9972660375987632, 0.9977856006758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253, 0.9971647871349224, 0.9979909559412948, 0.9976052922374462, 0.9976983102453126, 0.9973603423182615, 0.9977508280676429, 0.9974240532825538, 0.997471624135892, 0.9967403721739689, 0.9975277897232365, 0.9969625860235435, 0.9971359797851856, 0.997482792293162, 0.9980933432086161, 0.997933166348978, 0.9976543871569888, 0.997459606499098, 0.9972750945495694, 0.9977369115942663, 0.9979641973362922, 0.997524641652 0598, 0.9971857492914092, 0.9976005451459891, 0.977412839153449, 0.9975151474691457, 0.997550400869 3873, 0.9976773730735179, 0.9976221319197729, 0.9

973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9977952508498044, 0.9
975368091970049, 0.99752584091727, 0.9973335337438
751, 0.9973393052076993, 0.9974346717766025, 0.997
5973970748122, 0.9978567131918273, 0.9977493040014
384, 0.9972196535182893, 0.9978918166839178, 0.997
3982440958424, 0.9973941466063743, 0.9972725960803
815, 0.997860685757836, 0.9971477725597525, 0.9976
895905878467, 0.997655411529356, 0.9974826423850107]
n_estimators = 820

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32146689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1864612102508545, 4.44146990776062, 6.19
54281330210864, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.166547060012
817, 8.326849937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526
1306763, 10.52415680885315, 10.955713987350464, 11
.18612813949585, 12.054737091064453, 11.9042003154
75464, 12.338850259780884, 12.5204758644104, 12.79
7037124633789, 13.128127098083496, 13.581660032272
339, 13.837814092636108, 14.62335991859436, 14.878
289699554443, 15.102436304092407, 15.2237489223480
22, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183, 19.6154582
50045776, 18.156204223632812, 18.76840877532959, 1
9.425849199295044, 21.50138211250305, 22.101943016
052246, 23.14012598991394, 20.03169584274292, 22.0
84593296051025, 21.98842206954956, 20.49926090240
4785, 20.61261296272278, 20.80902123451233, 21.422
63889312744, 23.935853719711304, 27.92972707748413

, 24.841004848480225, 23.48153781890869, 23.012959
957122803, 23.671861171722412, 26.680218935012817,
24.52654004096985, 29.90683078765869, 29.034919977
18811, 26.721741914749146, 25.861357927322388]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.996956946279016, 0.9957189979699438,
0.9982670367865609, 0.996889405861029, 0.996857562
871229, 0.998813427013269, 0.9975229801700497, 0.9
9685485203216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.9968955271105392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
977369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9977952508498044, 0.9
975368091970049, 0.99752584091727, 0.9973335337438
751, 0.9973393052076993, 0.9974346717766025, 0.997
5973970748122, 0.9978567131918273, 0.9977493040014
384, 0.9972196535182893, 0.9978918166839178, 0.997
3982440958424, 0.9973941466063743, 0.9972725960803
815, 0.997860685757836, 0.9971477725597525, 0.9976
895905878467, 0.997655411529356, 0.99748264238501 0
7, 0.9978263817758859]
n_estimators = 830

Execution time of IsolationForest applied on Shutt
le (in second)

[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.18646121025085545, 4.44146990776062, 6.1954428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.32649937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537, 9.324568033218384, 9.652966976165771, 10.455974102020264, 10.322875261306763, 10.52415680885315, 10.955713987350464, 11.18612813949585, 12.054737091064453, 11.90420031547546, 12.338850259780884, 12.5204758644104, 12.797037124633789, 13.128127098083496, 13.581660032272339, 13.837814092636108, 14.62335991859436, 14.878289699554443, 15.102436304092407, 15.223748922348022, 15.394045114517212, 16.53843402862549, 15.700670003890991, 16.38036823272705, 17.5802059173584, 18.111566066741943, 19.351031064987183, 19.615458250045776, 18.156204223632812, 18.76840877532959, 19.425849199295044, 21.50138211250305, 22.101943016052246, 23.14012598991394, 20.03169584274292, 22.084593296051025, 21.982842206954956, 20.499260902404785, 20.61261296272278, 20.80902123451233, 21.42263889312744, 23.935853719711304, 27.92972707748413, 24.84100848480225, 23.48153781890869, 23.012959957122803, 23.671861171722412, 26.680218935012817, 24.52654004096985, 29.90683078765869, 29.03491997718811, 26.721741914749146, 25.861357927322388, 27.161956787109375]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.9968548520321, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.9978229838577904, 0.9976194960347794, 0.9974970835369169, 0.9968053073881633, 0.9968955271105392, 0.9976609831156645, 0.9980709569246922, 0.9972660375987632, 0.9977856606758739, 0.9967404221433528, 0.9974054396871037, 0.9974481635102173, 0.9976948873425253, 0.9971647871349224, 0.9979909559412948, 0.9976052922374462, 0.9976983102453126, 0.9973603423182615, 0.997750

8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
977369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9977952508498044, 0.9
975368091970049, 0.99752584091727, 0.9973335337438
751, 0.9973393052076993, 0.9974346717766025, 0.997
59973970748122, 0.9978567131918273, 0.9977493040014
384, 0.9972196535182893, 0.9978918166839178, 0.997
3982440958424, 0.9973941466063743, 0.9972725960803
815, 0.997860685757836, 0.9971477725597525, 0.9976
895905878467, 0.997655411529356, 0.9974826423850107
7, 0.9978263817758859, 0.9977823837334865]
n_estimators = 840

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1864612102508545, 4.44146990776062, 6.19
54281330108664, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.166547060012
817, 8.326849937438965, 8.584643125534058, 8.95337
8915786743, 9.236348814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526
1306763, 10.52415680885315, 10.955713987350464, 11
.18612813949585, 12.054737091064453, 11.9042003154
75464, 12.338850259780884, 12.52047586441104, 12.79
7037124633789, 13.128127098083496, 13.581660032272
339, 13.837814092636108, 14.62335991859436, 14.878
289699554443, 15.104363040924070, 15.2237489223480

22, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183, 19.6154582
50045776, 18.156204223632812, 18.76840877532959, 1
9.425849199295044, 21.50138211250305, 22.101943016
052246, 23.14012598991394, 20.03169584274292, 22.0
84593296051025, 21.982842206954956, 20.49926090240
4785, 20.61261296272278, 20.80902123451233, 21.422
63889312744, 23.935853719711304, 27.92972707748413
, 24.841004848480225, 23.48153781890869, 23.012959
957122803, 23.671861171722412, 26.680218935012817,
24.52654004096985, 29.90683078765869, 29.034919977
18811, 26.721741914749146, 25.861357927322388, 27.
161956787109375, 28.496459007263184]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.9982670367865609, 0.996889405861029, 0.996857562
871229, 0.9988134270132269, 0.9975229801700497, 0.9
9685485203216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.99689552711105392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
973369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9977952508498044, 0.9
975368091970049, 0.99752584091727, 0.9973335337438
751, 0.9973393052076993, 0.9974346717766025, 0.997
59973970748122, 0.9978567131918273, 0.9977493040014
384, 0.9972196535182893, 0.9978918166839178, 0.997
3982440958424, 0.9973941466063743, 0.9972725960803
815, 0.997860685757836, 0.9971477725597525, 0.9976
895905878467, 0.997655411529356, 0.9974826423850107
7, 0.9978263817758859, 0.9977823837334865, 0.99715

```
2244819599]
n_estimators = 850

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1864612102508545, 4.44146990776062, 6.19
54281330 10864, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.166547060012
817, 8.326849937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526
1306763, 10.52415680885315, 10.955713987350464, 11
.18612813949585, 12.054737091064453, 11.9042003154
75464, 12.338850259780884, 12.5204758644104, 12.79
7037124633789, 13.128127098083496, 13.581660032272
339, 13.837814092636108, 14.62335991859436, 14.878
289699554443, 15.102436304092407, 15.2237489223480
22, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183, 19.6154582
50045776, 18.156204223632812, 18.76840877532959, 1
9.425849199295044, 21.50138211250305, 22.101943016
052246, 23.14012598991394, 20.03169584274292, 22.0
84593296051025, 21.982842206954956, 20.49926090240
4785, 20.61261296272278, 20.80902123451233, 21.422
63889312744, 23.935853719711304, 27.92972707748413
, 24.841004848480225, 23.48153781890869, 23.012959
957122803, 23.671861171722412, 26.680218935012817,
24.52654004096985, 29.90683078765869, 29.034919977
18811, 26.721741914749146, 25.861357927322388, 27.
161956787109375, 28.496459007263184, 33.6317059993
7439]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
```

```
0.9982670367865609, 0.996889405861029, 0.996857562
871229, 0.998813427013269, 0.9975229801700497, 0.9
9685485203216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.9968955271105392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
973369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9977952508498044, 0.9
975368091970049, 0.99752584091727, 0.9973335337438
751, 0.9973393052076993, 0.9974346717766025, 0.997
5973970748122, 0.9978567131918273, 0.9977493040014
384, 0.9972196535182893, 0.9978918166839178, 0.997
3982440958424, 0.9973941466063743, 0.9972725960803
815, 0.997860685757836, 0.9971477725597525, 0.9976
895905878467, 0.997655411529356, 0.997482642385010
7, 0.9978263817758859, 0.9977823837334865, 0.99715
2244819599, 0.9970832620853204]
n_estimators = 860

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1864612102508545, 4.44146990776062, 6.19
```

5428133010864, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.165547060012
817, 8.326849937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526
1306763, 10.52415680885315, 10.955713987350464, 11
.18612813949585, 12.054737091064453, 11.9042003154
75464, 12.338850259780884, 12.5204758644104, 12.79
7037124633789, 13.128127098083496, 13.581660032272
339, 13.837814092636108, 14.62335991859436, 14.878
289699554443, 15.102436304092407, 15.2237489223480
22, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183, 19.6154582
50045776, 18.156204223632812, 18.76840877532959, 1
9.425849199295044, 21.50138211250305, 22.101943016
052246, 23.14012598991394, 20.03169584274292, 22.0
84593296051025, 21.982842206954956, 20.49926090240
4785, 20.61261296272278, 20.80902123451233, 21.422
63889312744, 23.935853719711304, 27.92972707748413
, 24.841004848480225, 23.48153781890869, 23.012959
957122803, 23.671861171722412, 26.680218935012817,
24.52654004096985, 29.90683078765869, 29.034919977
18811, 26.721741914749146, 25.861357927322388, 27.
161956787109375, 28.496459007263184, 33.6317059993
7439, 31.11049911499023]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.9982670367865609, 0.996889405861029, 0.996857562
871229, 0.998813427013269, 0.9975229801700497, 0.9
9685485203216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.9968955271105392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9

977369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9977952508498044, 0.9
975368091970049, 0.99752584091727, 0.9973335337438
751, 0.9973393052076993, 0.9974346717766025, 0.997
5973970748122, 0.9978567131918273, 0.9977493040014
384, 0.9972196535182893, 0.9978918166839178, 0.997
3982440958424, 0.9973941466063743, 0.9972725960803
815, 0.997860685757836, 0.9971477725597525, 0.9976
895905878467, 0.997655411529356, 0.997482642385010
7, 0.9978263817758859, 0.9977823837334865, 0.99715
2244819599, 0.9970832620853204, 0.9971958680916202
]
n_estimators = 870

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1864612102508545, 4.44146990776062, 6.19
5428133010864, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.166547060012
817, 8.326849937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526
1306763, 10.52415680885315, 10.955713987350464, 11
.18612813949585, 12.054737091064453, 11.9042003154
75464, 12.338850259780884, 12.5204758644104, 12.79
7037124633789, 13.128127098083496, 13.581660032272
339, 13.837814092636108, 14.62335991859436, 14.878
289699554443, 15.102436304092407, 15.2237489223480
22, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183, 19.6154582

50045776, 18.156204223632812, 18.76840877532959, 1
9.425849199295044, 21.50138211250305, 22.101943016
052246, 23.14012598991394, 20.03169584274292, 22.0
84593296051025, 21.982842206954956, 20.49926090240
4785, 20.61261296272278, 20.80902123451233, 21.422
63889312744, 23.935853719711304, 27.92972707748413
, 24.841004848480225, 23.48153781890869, 23.012959
957122803, 23.671861171722412, 26.680218935012817,
24.52654004096985, 29.90683078765869, 29.034919977
18811, 26.721741914749146, 25.861357927322388, 27.
161956787109375, 28.496459007263184, 33.6317059993
7439, 31.11049911499023, 30.450387001037598]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.9982670367865609, 0.996889405861029, 0.996857562
871229, 0.9988134270113269, 0.9975229801700497, 0.9
9685485203216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.99689552711 05392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
977369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9977952508498044, 0.9
975368091970049, 0.99752584091727, 0.9973335337438
751, 0.9973393052076993, 0.9974346717766025, 0.997
5973970748122, 0.9978567131918273, 0.9977493040014
384, 0.9972196535182893, 0.9978918166839178, 0.997
3982440958424, 0.9973941466063743, 0.9972725960803
815, 0.997860685757836, 0.9971477725597525, 0.9976
895905878467, 0.997655411529356, 0.997482642385010
7, 0.9978263817758859, 0.9977823837334865, 0.99715
2244819599, 0.9970832620853204, 0.9971958680916202
, 0.9974495626529626]

```
n_estimators = 880

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.18646121025008545, 4.44146990776062, 6.19
54281330810864, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.166547060012
817, 8.326849937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526
1306763, 10.52415680885315, 10.955713987350464, 11
.18612813949585, 12.054737091064453, 11.9042003154
75464, 12.338850259780884, 12.5204758644104, 12.79
7037124633789, 13.128127098083496, 13.581660032272
339, 13.837814092636108, 14.62335991859436, 14.878
289699554443, 15.102436304092407, 15.2237489223480
22, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183, 19.6154582
50045776, 18.156204223632812, 18.76840877532959, 1
9.425849199295044, 21.50138211250305, 22.101943016
052246, 23.14012598991394, 20.03169584274292, 22.0
84593296051025, 21.982842206954956, 20.49926090240
4785, 20.61261296272278, 20.80902123451233, 21.422
63889312744, 23.935853719711304, 27.92972707748413
, 24.841004848480225, 23.48153781890869, 23.012959
957122803, 23.671861171722412, 26.680218935012817,
24.52654004096985, 29.90683078765869, 29.034919977
18811, 26.721741914749146, 25.861357927322388, 27.
161956787109375, 28.49659007263184, 33.6317059993
7439, 31.11404911499023, 30.450387001037598, 28.8
42736959457397]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
```

0.99826703678656609, 0.996889405861029, 0.996857562
871229, 0.998813427013269, 0.9975229801700497, 0.9
9685485203216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782299385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.9968955271105392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
973369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9977952508498044, 0.9
975368091970049, 0.99752584091727, 0.9973335337438
751, 0.9973393052076993, 0.9974346717766025, 0.997
5973970748122, 0.9978567131918273, 0.9977493040014
384, 0.9972196535182893, 0.9978918166839178, 0.997
3982440958424, 0.9973941466063743, 0.9972725960803
815, 0.997860685757836, 0.9971477725597525, 0.9976
895905878467, 0.997655411529356, 0.997482642385010
7, 0.9978263817758859, 0.9977823837334865, 0.99715
2244819599, 0.9970832620853204, 0.9971958680916202
, 0.9974495626529626, 0.9979136283199284]
n_estimators = 890

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.6503298282629,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139

984131, 4.18646121025085545, 4.44146990776062, 6.19
5428133010864, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.166547060012
817, 8.326849937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526
1306763, 10.52415680885315, 10.955713987350464, 11
.18612813949585, 12.054737091064453, 11.9042003154
75464, 12.338850259780884, 12.5204758644104, 12.79
7037124633789, 13.128127098083496, 13.581660032272
339, 13.837814092636108, 14.62335991859436, 14.878
289699554443, 15.104436304092407, 15.2237489223480
22, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183, 19.6154582
50045776, 18.156204223632812, 18.76840877532959, 1
9.425849199295044, 21.50138211250305, 22.101943016
052246, 23.14012598991394, 20.03169584274292, 22.0
84593296051025, 21.982842206954956, 20.49926090240
4785, 20.61261296272278, 20.80902123451233, 21.422
63889312744, 23.935853719711304, 27.92972707748413
, 24.841004848480225, 23.48153781890869, 23.012959
957122803, 23.671861171722412, 26.680218935012817,
24.52654004096985, 29.90683078765869, 29.034919977
18811, 26.721741914749146, 25.861357927322388, 27.
161956787109375, 28.496459007263184, 33.6317059993
7439, 31.11404991149023, 30.450387001037598, 28.8
42736959457397, 32.654866218566895]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.9982670367865609, 0.996889405861029, 0.996857562
871229, 0.998813427013269, 0.9975229801700497, 0.9
9685485203216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.9968955271105392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0

.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
977369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9977952508498044, 0.9
975368091970049, 0.99752584091727, 0.9973335337438
751, 0.9973393052076993, 0.9974346717766025, 0.997
59739770748122, 0.9978567131918273, 0.9977493040014
384, 0.9972196535182893, 0.9978918166839178, 0.997
3982440958424, 0.9973941466063743, 0.9972725960803
815, 0.997860685757836, 0.9971477725597525, 0.9976
895905878467, 0.997655411529356, 0.997482642385010
7, 0.9978263817758859, 0.9977823837334865, 0.99715
2244819599, 0.9970832620853204, 0.9971958680916202
, 0.9974495626529626, 0.9979136283199284, 0.997394
0716522987]
n_estimators = 900

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1864612102508545, 4.44146990776062, 6.19
54281330810864, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.166547060012
817, 8.326849937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526
1306763, 10.52415680885315, 10.955713987350464, 11
.18612813949585, 12.054737091064453, 11.9042003154
75464, 12.338850259780884, 12.5204758644104, 12.79
7037124633789, 13.128127098083496, 13.581660032272
339, 13.837814092636108, 14.62335991859436, 14.878
289699554443, 15.102436304092407, 15.223748922348 0

22, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183, 19.6154582
50045776, 18.156204223632812, 18.76840877532959, 1
9.425849199295044, 21.50138211250305, 22.101943016
052246, 23.14012598991394, 20.03169584274292, 22.0
84593296051025, 21.982842206954956, 20.49926090240
4785, 20.61261296272278, 20.80902123451233, 21.422
63889312744, 23.935853719711304, 27.92972707748413
, 24.841004848480225, 23.48153781890869, 23.012959
957122803, 23.671861171722412, 26.680218935012817,
24.52654004096985, 29.90683078765869, 29.034919977
18811, 26.721741914749146, 25.861357927322388, 27.
161956787109375, 28.496459007263184, 33.6317059993
7439, 31.114049911499023, 30.450387001037598, 28.8
42736959457397, 32.654866218566895, 29.65787506103
5156]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.9982670367865609, 0.996889405861029, 0.996857562
871229, 0.9988134270132269, 0.9975229801700497, 0.9
9685485203216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.99689552271105392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
977369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9977952508498044, 0.9
975368091970049, 0.99752584091727, 0.9973335337438
751, 0.9973393052076993, 0.9974346717766025, 0.997
5973970748122, 0.9978567131918273, 0.9977493040014
384, 0.9972196535182893, 0.9978918166839178, 0.997
3982440958424, 0.9973941466063743, 0.9972725960803

815, 0.997860685757836, 0.9971477725597525, 0.9976
895905878467, 0.997655411529356, 0.997482642385010
7, 0.9978263817758859, 0.9977823837334865, 0.99715
2244819599, 0.9970832620853204, 0.9971958680916202
, 0.9974495626529626, 0.9979136283199284, 0.997394
0716522987, 0.9970877843145505]
n_estimators = 910

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1864612102508545, 4.44146990776062, 6.19
5428133010864, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.166547060012
817, 8.326849937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526
1306763, 10.52415680885315, 10.955713987350464, 11
.18612813949585, 12.054737091064453, 11.9042003154
75464, 12.338850259780884, 12.5204758644104, 12.79
7037124633789, 13.128127098083496, 13.581660032272
339, 13.837814092636108, 14.62335991859436, 14.878
289699554443, 15.102436304092407, 15.2237489223480
22, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183, 19.6154582
50045776, 18.156204223632812, 18.76840877532959, 1
9.425849199295044, 21.50138211250305, 22.101943016
052246, 23.14012598991394, 20.03169584274292, 22.0
84593296051025, 21.982842206954956, 20.49926090240
4785, 20.61261296272278, 20.80902123451233, 21.422
63889312744, 23.935853719711304, 27.92972707748413
, 24.841004848480225, 23.481537781890869, 23.012959
957122803, 23.671861171722412, 26.680218935012817,
24.52654004096985, 29.90683078765869, 29.034919977
18811, 26.721741914749146, 25.861357927322388, 27.

161956787109375, 28.496459007263184, 33.6317059993
7439, 31.114049911499023, 30.450387001037598, 28.8
42736959457397, 32.654866218566895, 29.65787506103
5156, 28.111203670050171]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.99826703678656609, 0.996889405861029, 0.996857562
871229, 0.998813427013269, 0.9975229801700497, 0.9
9685485203216, 0.99652846450979947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.99689552711055392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
977369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9977952508498044, 0.9
975368091970049, 0.99752584091727, 0.9973335337438
751, 0.9973393052076993, 0.9974346717766025, 0.997
5973970748122, 0.9978567131918273, 0.9977493040014
384, 0.9972196535182893, 0.9978918166839178, 0.997
3982440958424, 0.9973941466063743, 0.9972725960803
815, 0.997860685757836, 0.9971477725597525, 0.9976
895905878467, 0.997655411529356, 0.997482642385010
7, 0.9978263817758859, 0.9977823837334865, 0.99715
2244819599, 0.9970832620853204, 0.9971958680916202
, 0.9974495626529626, 0.9979136283199284, 0.997394
0716522987, 0.9970877843145505, 0.9975556726393737
]
n_estimators = 920

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1864612102508545, 4.44146990776062, 6.19
54281330108864, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.166547060012
817, 8.326849937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526
1306763, 10.52415680885315, 10.955713987350464, 11
.18612813949585, 12.054737091064453, 11.9042003154
75464, 12.338850259780884, 12.5204758644104, 12.79
7037124633789, 13.128127098083496, 13.581660032272
339, 13.837814092636108, 14.62335991859436, 14.878
289699554443, 15.102436304092407, 15.2237489223480
22, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183, 19.6154582
50045776, 18.156204223632812, 18.76840877532959, 1
9.425849199295044, 21.50138211250305, 22.101943016
052246, 23.14012598991394, 20.03169584274292, 22.0
84593296051025, 21.982842206954956, 20.49926090240
4785, 20.61261296272278, 20.80902123451233, 21.422
63889312744, 23.935853719711304, 27.92972707748413
, 24.841004848480225, 23.48153781890869, 23.012959
957122803, 23.671861171722412, 26.680218935012817,
24.52654004096985, 29.90683078765869, 29.034919977
18811, 26.72174194749146, 25.861357927322388, 27.
161956787109375, 28.49659007263184, 33.6317059993
7439, 31.11049911499023, 30.450387001037598, 28.8
42736959457397, 32.654866218566895, 29.65787506103
5156, 28.11120367050171, 31.491936922073364]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220

09664679, 0.9962956946279016, 0.9957189979699438,
0.9982670367865609, 0.996889405861029, 0.996857562
871229, 0.9988134270113269, 0.9975229801700497, 0.9
96854852032216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.9968955271105392, 0.99766093115645
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
973369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9977952508498044, 0.9
975368091970049, 0.99752584091727, 0.9973335337438
751, 0.9973393052076993, 0.9974346717766025, 0.997
59973970748122, 0.9978567131918273, 0.9977493040014
384, 0.9972196535182893, 0.9978918166839178, 0.997
3982440958424, 0.9973941466063743, 0.9972725960803
815, 0.997860685757836, 0.9971477725597525, 0.9976
895905878467, 0.997655411529356, 0.9974826423850107
7, 0.9978263817758859, 0.9977823837334865, 0.99715
2244819599, 0.9970832620853204, 0.9971958680916202
, 0.9974495626529626, 0.9979136283199284, 0.997394
0716522987, 0.9970877843145505, 0.9975556726393737
, 0.9974483134183686]
n_estimators = 930

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,

1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1864612102508545, 4.44146990776062, 6.19
54281330010864, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.166547060012
817, 8.326849937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526
1306763, 10.52415680885315, 10.955713987350464, 11
.18612813949585, 12.054737091064453, 11.9042003154
75464, 12.338850259780884, 12.5204758644104, 12.79
7037124633789, 13.128127098083496, 13.581660032272
339, 13.837814092636108, 14.62335991859436, 14.878
289699554443, 15.102436304092407, 15.2237489223480
22, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183, 19.6154582
50045776, 18.156204223632812, 18.76840877532959, 1
9.425849199295044, 21.50138211250305, 22.101943016
052246, 23.14012598991394, 20.03169584274292, 22.0
84593296051025, 21.982842206954956, 20.49926090240
4785, 20.61261296272278, 20.80902123451233, 21.422
63889312744, 23.935853719711304, 27.92972707748413
, 24.841004848480225, 23.48153781890869, 23.012959
957122803, 23.671861171722412, 26.680218935012817,
24.52654004096985, 29.90683078765869, 29.034919977
18811, 26.721741914749146, 25.861357927322388, 27.
161956787109375, 28.496459007263184, 33.6317059993
7439, 31.11404991149023, 30.450387001037598, 28.8
42736959457397, 32.654866218566895, 29.65787506103
5156, 28.11120367050171, 31.491936922073364, 31.78
7033796310425]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.9982670367865609, 0.996889405861029, 0.996857562
871229, 0.998813427013269, 0.9975229801700497, 0.9
9685485203216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.9968955271105392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164

7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
977369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9977952508498044, 0.9
975368091970049, 0.99752584091727, 0.9973335337438
751, 0.9973393052076993, 0.9974346717766025, 0.997
5973970748122, 0.9978567131918273, 0.9977493040014
384, 0.9972196535182893, 0.9978918166839178, 0.997
3982440958424, 0.9973941466063743, 0.9972725960803
815, 0.997860685757836, 0.9971477725597525, 0.9976
895905878467, 0.997655411529356, 0.997482642385010
7, 0.9978263817758859, 0.9977823837334865, 0.99715
2244819599, 0.9970832620853204, 0.9971958680916202
, 0.9974495626529626, 0.9979136283199284, 0.997394
0716522987, 0.9970877843145505, 0.9975556726393737
, 0.9974483134183686, 0.9976657302071021]
n_estimators = 940

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1846612102508545, 4.44146990776062, 6.19
54281330810864, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.166547060012
817, 8.32849937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526

1306763, 10.52415680885315, 10.955713987350464, 11
.18612813949585, 12.054737091064453, 11.9042003154
75464, 12.338850259780884, 12.5204758644104, 12.79
7037124633789, 13.128127098083496, 13.581660032272
339, 13.837814092636108, 14.62335991859436, 14.878
289699554443, 15.10436304092407, 15.2237489223480
22, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183, 19.6154582
50045776, 18.156204223632812, 18.76840877532959, 1
9.425849199295044, 21.50138211250305, 22.101943016
052246, 23.14012598991394, 20.03169584274292, 22.0
84593296051025, 21.982842206954956, 20.49926090240
4785, 20.61261296272278, 20.80902123451233, 21.422
63889312744, 23.935853719711304, 27.92972707748413
, 24.841004848480225, 23.48153781890869, 23.012959
957122803, 23.671861171722412, 26.680218935012817,
24.52654004096985, 29.90683078765869, 29.034919977
18811, 26.721741914749146, 25.861357927322388, 27.
161956787109375, 28.496459007263184, 33.6317059993
7439, 31.114049911499023, 30.450387001037598, 28.8
42736959457397, 32.654866218566895, 29.65787506103
5156, 28.11120367050171, 31.491936922073364, 31.78
7033796310425, 31.223653078079224]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.9982670367865609, 0.996889405861029, 0.996857562
871229, 0.998813427013269, 0.9975229801700497, 0.9
9685485203216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.9968955271105392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
977369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9

973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9979952508498044, 0.9
975368091970049, 0.99752584091727, 0.9973335337438
751, 0.9973393052076993, 0.9974346717766025, 0.997
5973970748122, 0.9978567131918273, 0.9977493040014
384, 0.9972196535182893, 0.9978918166839178, 0.997
3982440958424, 0.9973941466063743, 0.9972725960803
815, 0.997860685757836, 0.9971477725597525, 0.9976
895905878467, 0.997655411529356, 0.9974826423850107, 0.9978263817758859, 0.9977823837334865, 0.99715
2244819599, 0.9970832620853204, 0.9971958680916202
, 0.9974495626529626, 0.9979136283199284, 0.997394
0716522987, 0.9970877843145505, 0.9975556726393737
, 0.9974483134183686, 0.9976657302071021, 0.997702
0079797108]
n_estimators = 950

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1864612102508545, 4.44146990776062, 6.19
54428133010864, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.166547060012
817, 8.326849937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526
1306763, 10.52415680885315, 10.955713987350464, 11
.18612813949585, 12.054737091064453, 11.9042003154
75464, 12.338850259780884, 12.5204758644104, 12.79
7037124633789, 13.128127098083496, 13.581660032272
339, 13.83781409263610, 14.6235991859436, 14.878
289699554443, 15.102436304092407, 15.2237489223480
22, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183, 19.6154582
50045776, 18.156204223632812, 18.76840877532959, 1

9.425849199295044, 21.50138211250305, 22.101943016
052246, 23.14012598991394, 20.03169584274292, 22.0
84593296051025, 21.982842206954956, 20.49926090240
4785, 20.61261296272278, 20.80902123451233, 21.422
63889312744, 23.935853719711304, 27.92972707748413
, 24.841004848480225, 23.48153781890869, 23.012959
957122803, 23.671861171722412, 26.680218935012817,
24.52654004096985, 29.90683078765869, 29.034919977
18811, 26.721741914749146, 25.861357927322388, 27.
161956787109375, 28.496459007263184, 33.6317059993
7439, 31.114049911499023, 30.450387001037598, 28.8
42736959457397, 32.654866218566895, 29.65787506103
5156, 28.11120367050171, 31.491936922073364, 31.78
7033796310425, 31.223653078079224, 31.389733076095
58]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.9982670367865609, 0.996889405861029, 0.996857562
871229, 0.998813427013269, 0.9975229801700497, 0.9
9685485203216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.9968955271105392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
977369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9977952508498044, 0.9
975368091970049, 0.99752584091727, 0.9973335337438
751, 0.9973393052076993, 0.9974346717766025, 0.997
59973970748122, 0.9978567131918273, 0.9977493040014
384, 0.9972196535182893, 0.9978918166839178, 0.997
3982440958424, 0.9973941466063743, 0.9972725960803
815, 0.997860685757836, 0.9971477725597525, 0.9976
895905878467, 0.997655411529356, 0.99748264238501 0

7, 0.9978263817758859, 0.9977823837334865, 0.99715
2244819599, 0.9970832620853204, 0.9971958680916202
, 0.9974495626529626, 0.9979136283199284, 0.997394
0716522987, 0.9970877843145505, 0.9975556726393737
, 0.9974483134183686, 0.9976657302071021, 0.997702
0079797108, 0.9973871259079561]
n_estimators = 960

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32144689559936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.650329828262329,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1864612102508545, 4.44146990776062, 6.19
5428133010864, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.166547060012
817, 8.326849937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526
1306763, 10.52415680885315, 10.955713987350464, 11
.18612813949585, 12.054737091064453, 11.9042003154
75464, 12.338850259780884, 12.5204758644104, 12.79
7037124633789, 13.128127098083496, 13.581660032272
339, 13.837814092636108, 14.62335991859436, 14.878
289699554443, 15.102436304092407, 15.2237489223480
22, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183, 19.6154582
50045776, 18.156204223632812, 18.76840877532959, 1
9.425849199295044, 21.50138211250305, 22.101943016
052246, 23.14012598991394, 20.03169584274292, 22.0
84593296051025, 21.982842206954956, 20.49926090240
4785, 20.61261296272278, 20.80902123451233, 21.422
63889312744, 23.935853719711304, 27.92972707748413
, 24.841004848480225, 23.481537781890869, 23.012959
957122803, 23.671861171722412, 26.680218935012817,
24.52654004096985, 29.90683078765869, 29.034919977
18811, 26.721741914749146, 25.861357927322388, 27.

161956787109375, 28.496459007263184, 33.6317059993
7439, 31.114049911499023, 30.450387001037598, 28.8
427369459457397, 32.654866218566895, 29.65787506103
5156, 28.11120367050171, 31.491936922073364, 31.78
7033796310425, 31.223653078079224, 31.389733076095
58, 32.93084526062012]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.9982670367865609, 0.996889405861029, 0.996857562
871229, 0.9988134427013269, 0.9975229801700497, 0.9
9685485203216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.99689552711055392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
973369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9977952508498044, 0.9
975368091970049, 0.99752584091727, 0.9973335337438
751, 0.9973393052076993, 0.9974346717766025, 0.997
59739970748122, 0.9978567131918273, 0.9977493040014
384, 0.9972196535182893, 0.9978918166839178, 0.997
3982440958424, 0.9973941466063743, 0.9972725960803
815, 0.997860685757836, 0.9971477725597525, 0.9976
895905878467, 0.997655411529356, 0.997482642385010
7, 0.9978263817758859, 0.9977823837334865, 0.99715
2244819599, 0.9970832620853204, 0.9971958680916202
, 0.9974495626529626, 0.9979136283199284, 0.997394
0716522987, 0.9970877843145505, 0.9975556726393737
, 0.9974483134183686, 0.9976657302071021, 0.997702
0079797108, 0.9973871259079561, 0.9973655641188643
]
n_estimators = 970

Execution time of IsolationForest applied on Shuttle (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1864612102508545, 4.44146990776062, 6.195428133010864, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.953378915786743, 9.236344814300537, 9.324568033218384, 9.652966976165771, 10.455974102020264, 10.322875261306763, 10.52415680885315, 10.955713987350464, 11.18612813949585, 12.054737091064453, 11.904200315475464, 12.338850259780884, 12.5204758644104, 12.797037124633789, 13.128127098083496, 13.581660032272339, 13.837814092636108, 14.62335991859436, 14.878289699554443, 15.102436304092407, 15.223748922348022, 15.394045114517212, 16.53843402862549, 15.700670003890991, 16.38036823272705, 17.5802059173584, 18.111566066741943, 19.351031064987183, 19.61545825045776, 18.156204223632812, 18.76840877532959, 19.425849199295044, 21.50138211250305, 22.101943016052246, 23.14012598991394, 20.03169584274292, 22.084593296051025, 21.982842206954956, 20.499260902404785, 20.61261296272278, 20.80902123451233, 21.42263889312744, 23.935853719711304, 27.92972707748413, 24.841004848480225, 23.48153781890869, 23.012959957122803, 23.671861171722412, 26.680218935012817, 24.52654004096985, 29.90683078765869, 29.03491997718811, 26.721741914749146, 25.861357927322388, 27.161956787109375, 28.496459007263184, 33.63170599937439, 31.11404911499023, 30.450387001037598, 28.842736959457397, 32.654866218566895, 29.657875061035156, 28.11120367050171, 31.491936922073364, 31.787033796310425, 31.223653078079224, 31.38973307609558, 32.93084526062012, 32.71388006210327]
ROC AUC for Isolation Forest applied on Shuttle

```
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.9962956946279016, 0.9957189979699438,
0.9982670367865609, 0.996889405861029, 0.996857562
871229, 0.998813427013269, 0.9975229801700497, 0.9
9685485203216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.9968955271105392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
977369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9977952508498044, 0.9
975368091970049, 0.99752584091727, 0.9973335337438
751, 0.9973393052076993, 0.9974346717766025, 0.997
5973970748122, 0.9978567131918273, 0.9977493040014
384, 0.9972196535182893, 0.9978918166839178, 0.997
3982440958424, 0.9973941466063743, 0.9972725960803
815, 0.997860685757836, 0.9971477725597525, 0.9976
895905878467, 0.997655411529356, 0.997482642385010
7, 0.9978263817758859, 0.9977823837334865, 0.99715
2244819599, 0.9970832620853204, 0.9971958680916202
, 0.9974495626529626, 0.9979136283199284, 0.997394
0716522987, 0.9970877843145505, 0.9975556726393737
, 0.9974483134183686, 0.9976657302071021, 0.997702
0079797108, 0.9973871259079561, 0.9973655641188643
, 0.9977272924878928]
n_estimators = 980
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)
```

```
Execution time of IsolationForest applied on Shutt
```

le (in second)
[0.32144689559936523, 0.6461000442504883, 1.0567457675933838, 1.2533798217773438, 1.650329828262329, 1.7771179676055908, 2.1839699745178223, 2.6413350105285645, 2.7329516410827637, 3.0031988620758057, 3.186779022216797, 3.7023820877075195, 3.876016139984131, 4.1846612102508545, 4.44146990776062, 6.1954281330108644, 5.409062147140503, 5.651955842971802, 6.242660045623779, 7.220815896987915, 6.727471113204956, 7.322738885879517, 7.790522813796997, 7.857840061187744, 8.300517082214355, 8.166547060012817, 8.326849937438965, 8.584643125534058, 8.9533789915786743, 9.236344814300537, 9.324568033218384, 9.652969976165771, 10.455974102020264, 10.322875261306763, 10.52415680885315, 10.955713987350464, 11.18612813949585, 12.054737091064453, 11.904200315475464, 12.338850259780884, 12.5204758644104, 12.797037124633789, 13.128127098083496, 13.581660032272339, 13.837814092636108, 14.62335991859436, 14.878289699554443, 15.102436304092407, 15.223748922348022, 15.394045114517212, 16.53843402862549, 15.700670003890991, 16.38036823272705, 17.5802059173584, 18.111566066741943, 19.351031064987183, 19.615458250045776, 18.156204223632812, 18.76840877532959, 19.425849199295044, 21.50138211250305, 22.101943016052246, 23.14012598991394, 20.03169584274292, 22.084593296051025, 21.982842206954956, 20.499260902404785, 20.61261296272278, 20.80902123451233, 21.42263889312744, 23.935853719711304, 27.92972707748413, 24.841004848480225, 23.48153781890869, 23.012959957122803, 23.671861171722412, 26.680218935012817, 24.52654004096985, 29.90683078765869, 29.03491997718811, 26.721741914749146, 25.861357927322388, 27.161956787109375, 28.496459007263184, 33.63170599937439, 31.114049911499023, 30.450387001037598, 28.842736959457397, 32.654866218566895, 29.657875061035156, 28.11120367050171, 31.491936922073364, 31.7870337963310425, 31.223653078079224, 31.38973307609558, 32.93084526062012, 32.71388006210327, 33.03667092323303]
ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.9915522009664679, 0.9962956946279016, 0.9957189979699438, 0.9982670367865609, 0.996889405861029, 0.996857562871229, 0.998813427013269, 0.9975229801700497, 0.99685485203216, 0.9965284645097947, 0.9984822049530254, 0.997255119288412, 0.9956581477528719, 0.9971667609255809, 0.9969935170720899, 0.99782298385779

04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.9968955271105392, 0.99766098311564
5, 0.9980709569246922, 0.9972660037987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750
8280676429, 0.9974240532825538, 0.99747162413589,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
973369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9977952508498044, 0.9
975368091970049, 0.99752584091727, 0.9973335337438
751, 0.9973393052076993, 0.9974346717766025, 0.997
5973970748122, 0.9978567131918273, 0.9977493040014
384, 0.9972196535182893, 0.9978918166839178, 0.997
3982440958424, 0.9973941466063743, 0.9972725960803
815, 0.997860685757836, 0.9971477725597525, 0.9976
895905878467, 0.997655411529356, 0.997482642385010
7, 0.9978263817758859, 0.9977823837334865, 0.99715
2244819599, 0.9970832620853204, 0.9971958680916202
, 0.9974495626529626, 0.9979136283199284, 0.997394
0716522987, 0.9970877843145505, 0.9975556726393737
, 0.9974483134183686, 0.9976657302071021, 0.997702
0079797108, 0.9973871259079561, 0.9973655641188643
, 0.9977272924878928, 0.9976912145928191]
n_estimators = 990

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[0.32146895599936523, 0.6461000442504883, 1.056745
7675933838, 1.2533798217773438, 1.6503298282623290,
1.7771179676055908, 2.1839699745178223, 2.64133501
05285645, 2.7329516410827637, 3.0031988620758057,
3.186779022216797, 3.7023820877075195, 3.876016139
984131, 4.1864612102508545, 4.44146990776062, 6.19

5428133010864, 5.409062147140503, 5.65195584297180
2, 6.242660045623779, 7.220815896987915, 6.7274711
13204956, 7.322738885879517, 7.790522813796997, 7.
857840061187744, 8.300517082214355, 8.165547060012
817, 8.326849937438965, 8.584643125534058, 8.95337
8915786743, 9.236344814300537, 9.324568033218384,
9.652966976165771, 10.455974102020264, 10.32287526
1306763, 10.52415680885315, 10.955713987350464, 11
.18612813949585, 12.054737091064453, 11.9042003154
75464, 12.338850259780884, 12.5204758644104, 12.79
7037124633789, 13.128127098083496, 13.581660032272
339, 13.837814092636108, 14.62335991859436, 14.878
289699554443, 15.102436304092407, 15.2237489223480
22, 15.394045114517212, 16.53843402862549, 15.7006
70003890991, 16.38036823272705, 17.5802059173584,
18.111566066741943, 19.351031064987183, 19.6154582
50045776, 18.156204223632812, 18.76840877532959, 1
9.425849199295044, 21.50138211250305, 22.101943016
052246, 23.14012598991394, 20.03169584274292, 22.0
84593296051025, 21.982842206954956, 20.49926090240
4785, 20.61261296272278, 20.80902123451233, 21.422
63889312744, 23.935853719711304, 27.92972707748413
, 24.841004848480225, 23.48153781890869, 23.012959
957122803, 23.671861171722412, 26.680218935012817,
24.52654004096985, 29.90683078765869, 29.034919977
18811, 26.721741914749146, 25.861357927322388, 27.
161956787109375, 28.496459007263184, 33.6317059993
7439, 31.11049911499023, 30.450387001037598, 28.8
42736959457397, 32.654866218566895, 29.65787506103
5156, 28.11120367050171, 31.491936922073364, 31.78
7033796310425, 31.223653078079224, 31.389733076095
58, 32.93084526062012, 32.71388006210327, 33.03667
092323303, 31.816042137146]
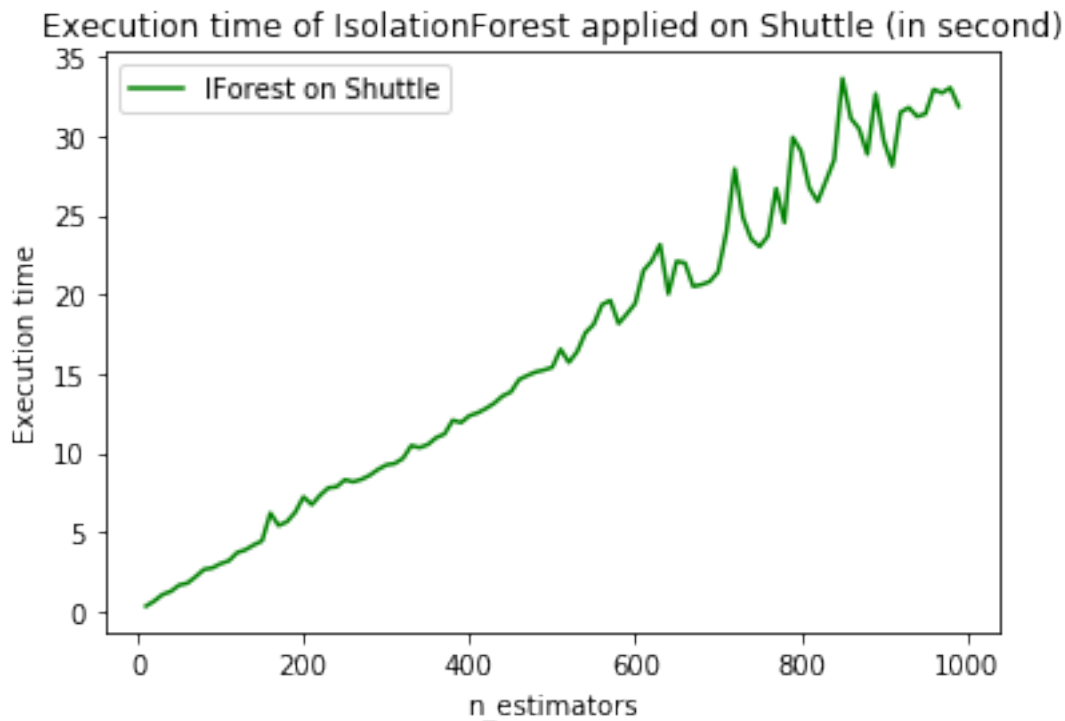ROC AUC for Isolation Forest applied on Shuttle
[0.995952230068637, 0.9986632315380367, 0.99155220
09664679, 0.996256946279016, 0.9957189979699438,
0.9982670367865609, 0.996889405861029, 0.996857562
871229, 0.998813427013269, 0.9975229801700497, 0.9
9685485203216, 0.9965284645097947, 0.9984822049530
254, 0.997255119288412, 0.9956581477528719, 0.9971
667609255809, 0.9969935170720899, 0.99782298385779
04, 0.9976194960347794, 0.9974970835369169, 0.9968
053073881633, 0.996895271105392, 0.99766098311564
5, 0.9980709569246922, 0.9972660375987632, 0.99778
5606758739, 0.9967404221433528, 0.9974054396871037
, 0.9974481635102173, 0.9976948873425253, 0.997164
7871349224, 0.9979909559412948, 0.9976052922374462
, 0.9976983102453126, 0.9973603423182615, 0.997750

8280676429, 0.9974240532825538, 0.997471624135892,
0.9967403721739689, 0.9975277897232365, 0.99696258
60235435, 0.9971359797851856, 0.997482792293162, 0
.9980933432086161, 0.997933166348978, 0.9976543871
569888, 0.997459606499098, 0.9972750945495694, 0.9
973369115942663, 0.9979641973362922, 0.99752464165
20598, 0.9971857492914092, 0.9976005451459891, 0.9
977412839153449, 0.9975151474691457, 0.99755040086
93873, 0.9976773730735179, 0.9976221319197729, 0.9
973627908180657, 0.9977902788961204, 0.99767522439
00163, 0.9973996182538959, 0.9979952508498044, 0.9
975368091970049, 0.99752584091727, 0.9973335337438
751, 0.9973393052076993, 0.9974346717766025, 0.997
5973970748122, 0.9978567131918273, 0.9977493040014
384, 0.9972196535182893, 0.9978918166839178, 0.997
3982440958424, 0.9973941466063743, 0.9972725960803
815, 0.997860685757836, 0.9971477725597525, 0.9976
895905878467, 0.997655411529356, 0.997482642385010
7, 0.9978263817758859, 0.9977823837334865, 0.99715
2244819599, 0.9970832620853204, 0.9971958680916202
, 0.9974495626529626, 0.9979136283199284, 0.997394
0716522987, 0.9970877843145505, 0.9975556726393737
, 0.9974483134183686, 0.9976657302071021, 0.997702
0079797108, 0.9973871259079561, 0.9973655641188643
, 0.9977272924878928, 0.9976912145928191, 0.997500
4314856288]

Résultat de Isolation Forest sur Shuttle

```
plt.plot(range(10, 1000, 10), executions_time_IF_Shuttle,   "g-
", label="IForest on Shuttle")
plt.xlabel('n_estimators')
plt.ylabel('Execution time')
plt.title("Execution time of IsolationForest applied on Shuttl
e (in second)")
plt.legend(loc="best")
plt.show()
```

Execution time of IsolationForest applied on Shuttle (in second)

```python
plt.plot(range(10, 1000, 10), roc_auc_IF_Shuttle,  "g-", label
="ROC AUC of IForest on Shuttle")
plt.xlabel('n_estimators')
plt.ylabel('AUC')
plt.title("ROC AUC for Isolation Forest applied on Shuttle")
plt.legend(loc="best")
plt.show()
```


ROC AUC for Isolation Forest applied on Shuttle
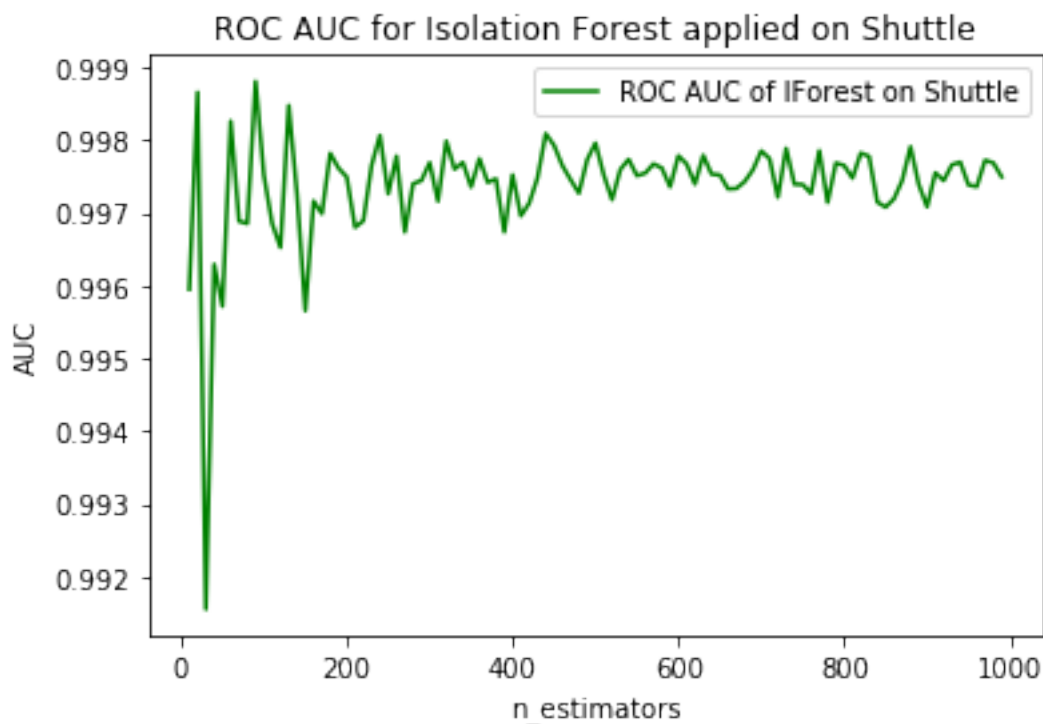
```python
index = roc_auc_IF_Shuttle.index(max(roc_auc_IF_Shuttle))
print("La meilleure est "+str(max(roc_auc_IF_Shuttle))+" pour
un temps d'exécution de "+str(executions_time_IF_Shuttle[index
])+"s obtenue avec un n_estimators de "+str(n_estimators_IF_Sh
uttle[index])+" donnant un rappel de "+str(recalls_IF_Shuttle[
index])+" et une spécificité de "+str(specificity_IF_Shuttle[i
ndex]))
```

La meilleure est 0.998813427013269 pour un temps d
'exécution de 2.7329516410827637s obtenue avec un
n_estimators de 90 donnant un rappel de 0.91725529
7679112 et une spécificité de 0.9965831435079726

In [22]:

```python
# Evolution de spécificité et rappel
plt.plot(n_estimators_IF_Shuttle, recalls_IF_Shuttle, "g-", la
bel="Rappel")
plt.plot(n_estimators_IF_Shuttle, specificity_IF_Shuttle, "b--
", label="Spécificité")
plt.title("Courbe Spécificité_Rappel")
#plt.axis([0, 1, 0, 1])
plt.xlabel('n_estimators')
plt.ylabel('Metrics Value')
plt.legend(loc="best")

plt.show()
```
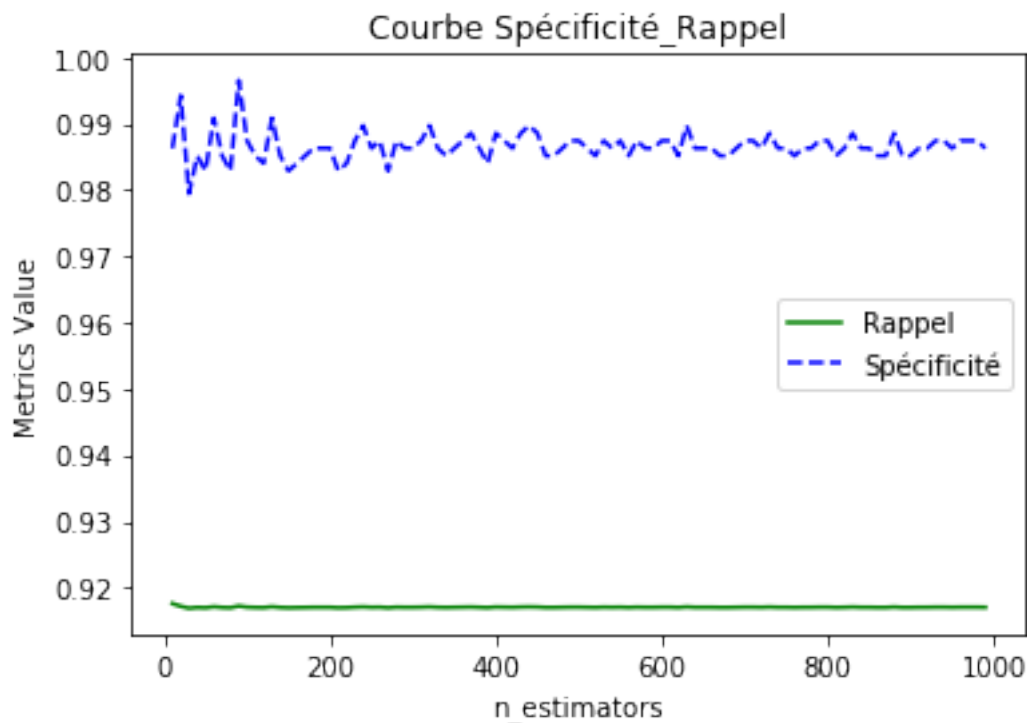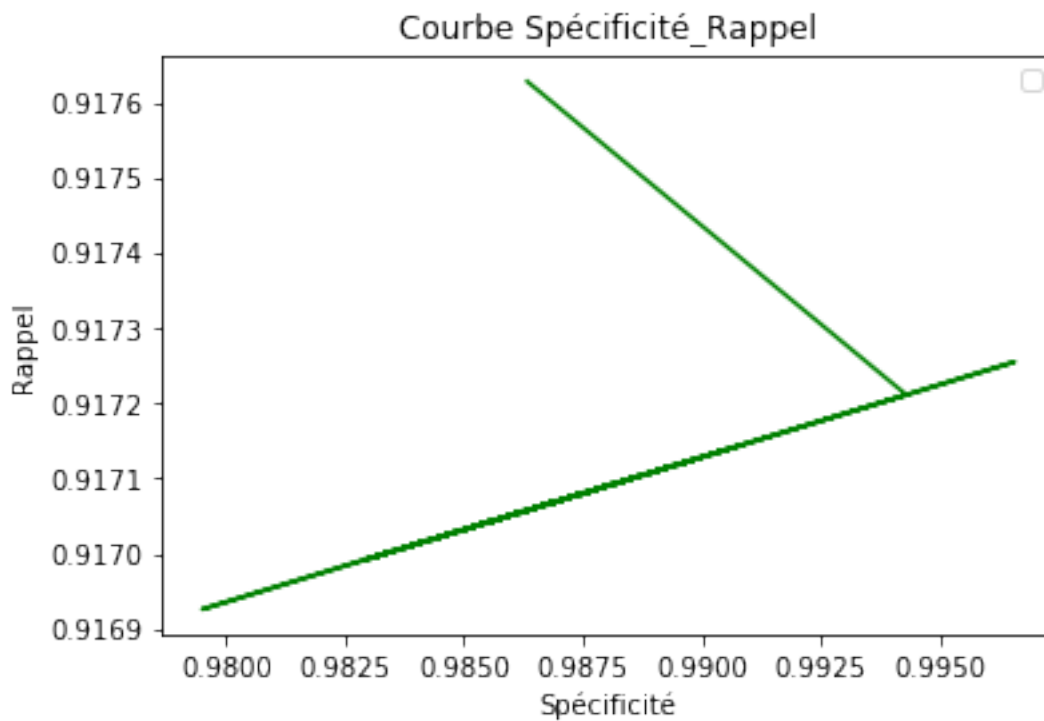
```python
# Evolution de spécificité et rappel
plt.plot(specificity_IF_Shuttle, recalls_IF_Shuttle, "g-")
plt.title("Compromis Spécificité_Rappel")
#plt.axis([0, 1, 0, 1])
plt.xlabel('Spécificité')
plt.ylabel('Rappel')
plt.legend(loc="best")

plt.show()
```

No handles with labels found to put in legend.

```python
import matplotlib.cm as cm
plt.scatter(specificity_IF_Shuttle,recalls_IF_Shuttle, c=n_est
imators_IF_Shuttle, cmap=cm.hsv)
cbar= plt.colorbar()
plt.show()
```
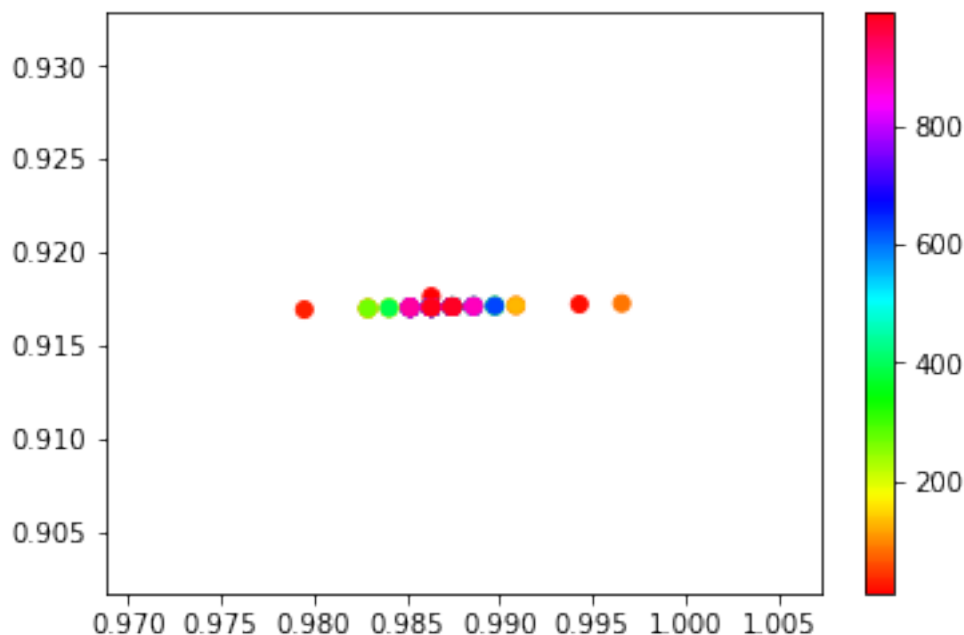

Résultat

Faisant varier n_estimators et max_samples = 256, contamination = 0,1

L'augmentation du nombre d'arbres augmente le temps d'exécution. L'écart est léger la AUC est aléatoire avec quelques pics. Quelque soit le nombre d'estimateur, la AUC > 0,94

Meilleure estimation :

```
   – Temps   = 2.9633030891418457
   – ROC AUC = 0.954597443146584 à n_estimators : 80 ==> 1
   5 * 5 + 5
```

Le nombre d'estimateur a une influence sur la performance de IForest pouvant l'améliorer comme la détérioré. Cela s'explique par le caractère aléatoire de la construction de l'arbre.

Exécution de Isolation Forest sur le jeux de données Shuttle en faisant varier max_samples

```python
MS_executions_time_IF_Shuttle = []
MS_roc_auc_IF_Shuttle = []
MS_precisions_IF_Shuttle = []
MS_recalls_IF_Shuttle = []
MS_f1_scores_IF_Shuttle = []
MS_tn_IF_Shuttle = []
MS_fp_IF_Shuttle = []
MS_fn_IF_Shuttle = []
MS_tp_IF_Shuttle = []
MS_specificity_IF_Shuttle = []
MS_max_samples_IF_Shuttle = []


for j in range(100, len(X_Shuttle), 1000):
    print("max_samples = "+str(j))
    max_samples = j
    MS_max_samples_IF_Shuttle.append(j)
    start_IF_Shuttle = time()

    # Instanciation, fit and predict on Shuttle
    MS_func_IF_Shuttle = IsolationForest(max_samples=max_sampl
es, behaviour="new")
    MS_func_IF_Shuttle.fit(X_Shuttle)
    MS_y_pred_IF_Shuttle = MS_func_IF_Shuttle.predict(X_Shuttl
e)

    # Calcul du temps d'exécution
    MS_exec_time_IF_Shuttle = time() - start_IF_Shuttle
    MS_executions_time_IF_Shuttle.append(MS_exec_time_IF_Shutt
le)

    # Precision
    MS_precisions_IF_Shuttle.append(precision_score(y_transfor
m_Shuttle, MS_y_pred_IF_Shuttle))

    # Recall
    MS_recalls_IF_Shuttle.append(recall_score(y_transform_Shut
tle, MS_y_pred_IF_Shuttle))

    # f1_score
    MS_f1_scores_IF_Shuttle.append(f1_score(y_transform_Shuttl
e, MS_y_pred_IF_Shuttle))
```

```python
    # Specificity
    MS_specificity_IF_Shuttle.append(specificity_score(y_trans
form_Shuttle, MS_y_pred_IF_Shuttle))

    # Matrice de confusion
    ttn, tfp, tfn, ttp = confusion_matrix(y_transform_Shuttle,
MS_y_pred_IF_Shuttle).ravel()
    tn = ttp
    fp = tfn
    fn = tfp
    tp = ttn
    MS_tn_IF_Shuttle.append(tn)
    MS_fp_IF_Shuttle.append(fp)
    MS_fn_IF_Shuttle.append(fn)
    MS_tp_IF_Shuttle.append(tp)

    # Calcul de l'aire sous la courbe ROC
    MS_y_DF_IF_Shuttle = MS_func_IF_Shuttle.decision_function(
X_Shuttle)
    MS_auc_IF_Shuttle = roc_auc_score(y_transform_Shuttle, MS_
y_DF_IF_Shuttle)
    MS_roc_auc_IF_Shuttle.append(MS_auc_IF_Shuttle)
```

```
max_samples = 100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 1100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 2100
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 3100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 4100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 5100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 6100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 7100
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 8100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 9100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 10100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 11100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 12100
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 13100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 14100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 15100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 16100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 17100
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 18100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 19100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 20100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 21100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 22100
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 23100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 24100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 25100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 26100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 27100
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 28100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 29100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 30100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 31100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 32100
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 33100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 34100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 35100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 36100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 37100
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 38100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 39100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 40100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 41100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 42100
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 43100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 44100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 45100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)

max_samples = 46100

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)
```
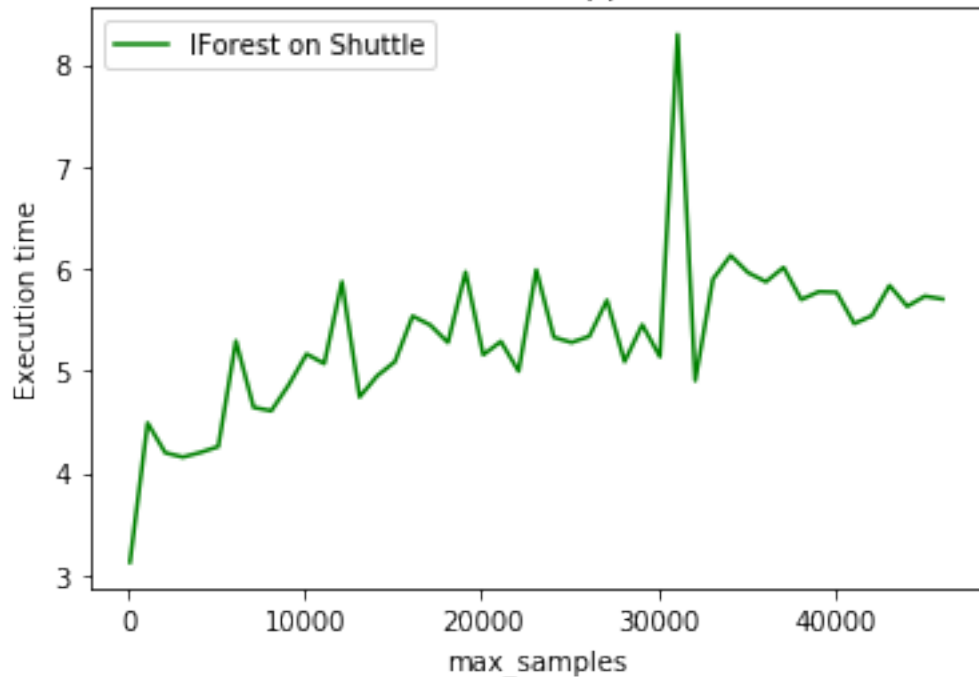
```
plt.plot(MS_max_samples_IF_Shuttle, MS_executions_time_IF_Shut
tle,  "g-", label="IForest on Shuttle")
plt.xlabel('max_samples')
plt.ylabel('Execution time')
plt.title("Execution time of IsolationForest applied on Shuttl
e (in second)")
plt.legend(loc="best")
plt.show()
```


Execution time of IsolationForest applied on Shuttle (in second)

In [33]:

```
plt.plot(MS_max_samples_IF_Shuttle, MS_roc_auc_IF_Shuttle,  "g
-", label="ROC AUC of IForest on Shuttle")
plt.xlabel('max_samples')
plt.ylabel('AUC')
plt.title("ROC AUC for Isolation Forest applied on Shuttle")
plt.legend(loc="best")
plt.show()
```
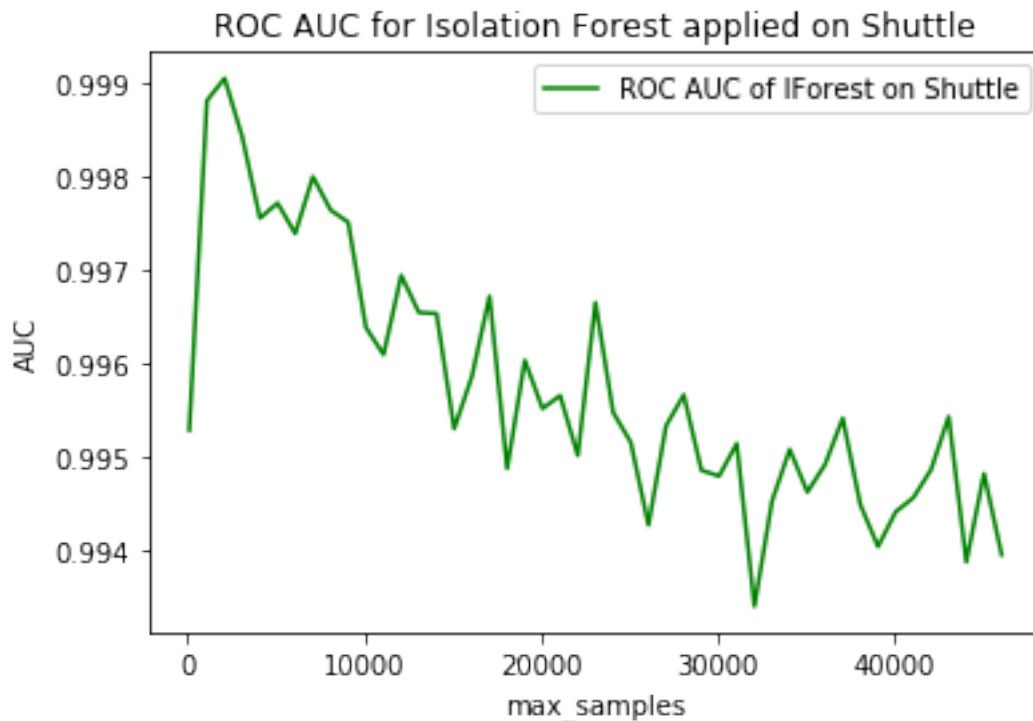

In [34]:

```
MS_index = MS_roc_auc_IF_Shuttle.index(max(MS_roc_auc_IF_Shutt
le))
print("La meilleure est "+str(max(MS_roc_auc_IF_Shuttle))+" po
ur un temps d'exécution de "+str(MS_executions_time_IF_Shuttle
[MS_index])+"s obtenue avec un max_samples de "+str(MS_max_sam
ples_IF_Shuttle[MS_index])+" donnant un rappel de "+str(MS_rec
alls_IF_Shuttle[MS_index])+" et une spécificité de "+str(MS_sp
ecificity_IF_Shuttle[MS_index]))
```

La meilleure est 0.9990598510292744 pour un temps
d'exécution de 4.200182914733887s obtenue avec un
max_samples de 2100 donnant un rappel de 0.9173211
07357522 et une spécificité de 1.0

In [35]:

```python
# Evolution de spécificité et rappel
plt.plot(MS_max_samples_IF_Shuttle, MS_recalls_IF_Shuttle, "g-", label="Rappel")
plt.plot(MS_max_samples_IF_Shuttle, MS_specificity_IF_Shuttle, "b--", label="Spécificité")
plt.title("Courbe Spécificité_Rappel")
#plt.axis([0, 1, 0, 1])
plt.xlabel('max_samples')
plt.ylabel('Metrics Value')
plt.legend(loc="best")

plt.show()
```
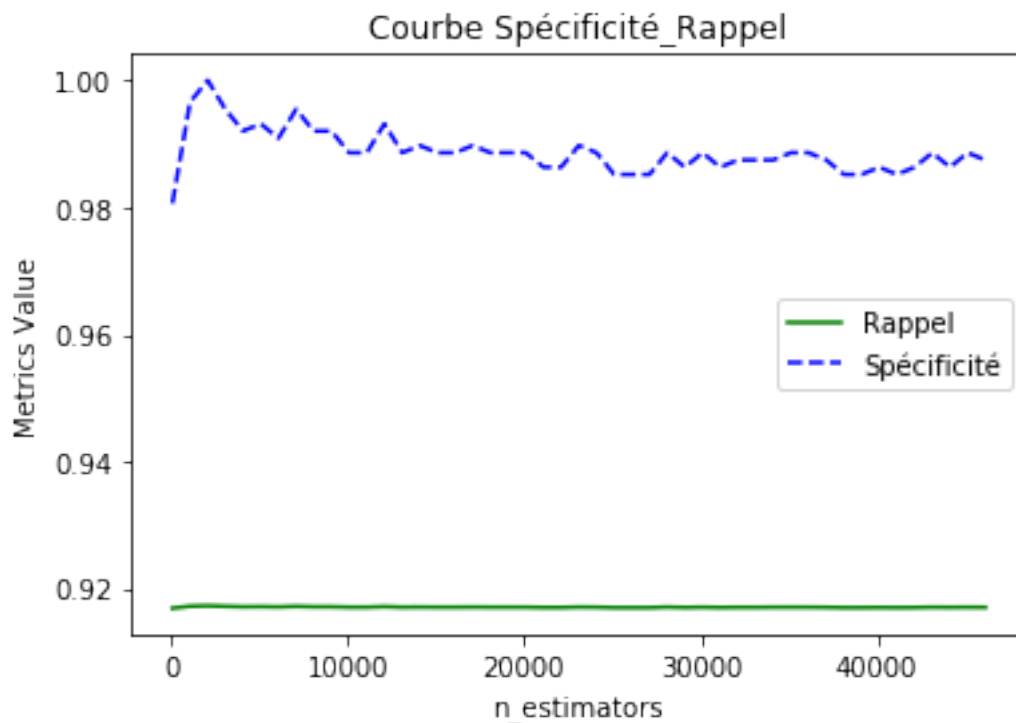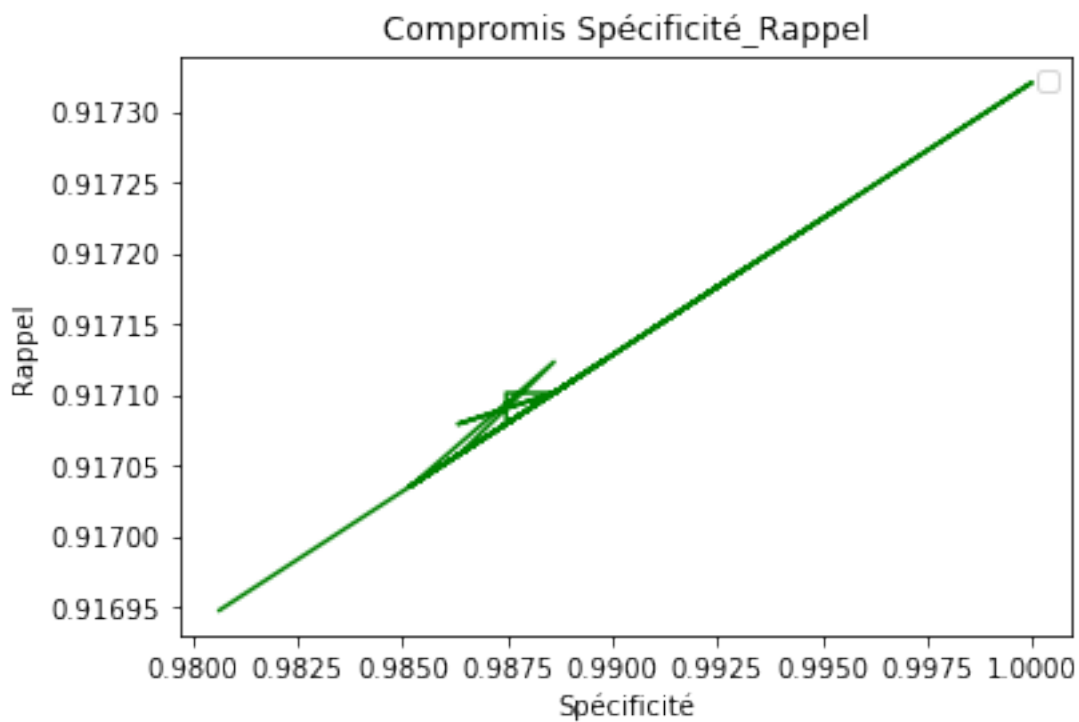
```python
# Evolution de spécificité et rappel
plt.plot(MS_specificity_IF_Shuttle, MS_recalls_IF_Shuttle, "g-
")
plt.title("Compromis Spécificité_Rappel")
#plt.axis([0, 1, 0, 1])
plt.xlabel('Spécificité')
plt.ylabel('Rappel')
plt.legend(loc="best")

plt.show()
```

No handles with labels found to put in legend.

Résultat

Faisant varier max_samples, n_estimators = 100, contamination = 0,1

Plus le nombre d'éléments dans l'échantillon augmente, plus le temps d'exécution est long. Par contre, quelque soit max_samples, la AUC ne varie pas beaucoup : entre 0,950 et 0,958.

Meilleure estimation :

```
- Temps    = 3.8525819778442383
- ROC AUC = 0.958660553678761 à max_samples : 1610 ==>
16 * 100 +10
```

Max_samples n'a donc pas une grande incidence sur les performances de classification de IForest pour un jeu de données de taille et de dimension faibles. Mais il a une conséquences sur le temps d'exécution.

Exécution de Isolation Forest sur le jeux de données Shuttle en faisant varier contamination (contamination : float in (0., 0.5), optional (default=0.1))

In [38]:

```python
CONT_executions_time_IF_Shuttle = []
CONT_roc_auc_IF_Shuttle = []
CONT_precisions_IF_Shuttle = []
CONT_recalls_IF_Shuttle = []
CONT_f1_scores_IF_Shuttle = []
CONT_tn_IF_Shuttle = []
CONT_fp_IF_Shuttle = []
CONT_fn_IF_Shuttle = []
CONT_tp_IF_Shuttle = []
CONT_specificity_IF_Shuttle = []
CONT_contamination_IF_Shuttle = []

for j in np.arange(0., 0.5, 0.01):
    print("contamination = "+str(j))
```

```python
        contamination = j

    CONT_contamination_IF_Shuttle.append(j)
    start_IF_Shuttle = time()

    # Instanciation, fit and predict on Shuttle
    CONT_func_IF_Shuttle = IsolationForest(contamination=conta
mination, behaviour="new")
    CONT_func_IF_Shuttle.fit(X_Shuttle)
    CONT_y_pred_IF_Shuttle = CONT_func_IF_Shuttle.predict(X_Sh
uttle)

    # Calcul du temps d'exécution
    CONT_exec_time_IF_Shuttle = time() - start_IF_Shuttle
    CONT_executions_time_IF_Shuttle.append(CONT_exec_time_IF_S
huttle)

    # Precision
    CONT_precisions_IF_Shuttle.append(precision_score(y_transf
orm_Shuttle, CONT_y_pred_IF_Shuttle))

    # Recall
    CONT_recalls_IF_Shuttle.append(recall_score(y_transform_Sh
uttle, CONT_y_pred_IF_Shuttle))

    # f1_score
    CONT_f1_scores_IF_Shuttle.append(f1_score(y_transform_Shut
tle, CONT_y_pred_IF_Shuttle))

    # Specificity
    CONT_specificity_IF_Shuttle.append(specificity_score(y_tra
nsform_Shuttle, CONT_y_pred_IF_Shuttle))

    # Matrice de confusion
    ttn, tfp, tfn, ttp = confusion_matrix(y_transform_Shuttle,
CONT_y_pred_IF_Shuttle).ravel()
    tn = ttp
    fp = tfn
    fn = tfp
    tp = ttn
    CONT_tn_IF_Shuttle.append(tn)
    CONT_fp_IF_Shuttle.append(fp)
    CONT_fn_IF_Shuttle.append(fn)
    CONT_tp_IF_Shuttle.append(tp)

    # Calcul de l'aire sous la courbe ROC
    CONT_y_DF_IF_Shuttle = CONT_func_IF_Shuttle.decision_funct
ion(X_Shuttle)
    CONT_auc_IF_Shuttle = roc_auc_score(y_transform_Shuttle, C
```

```
                                          (__            __      ,
ONT_y_DF_IF_Shuttle)

    CONT_roc_auc_IF_Shuttle.append(CONT_auc_IF_Shuttle)
```
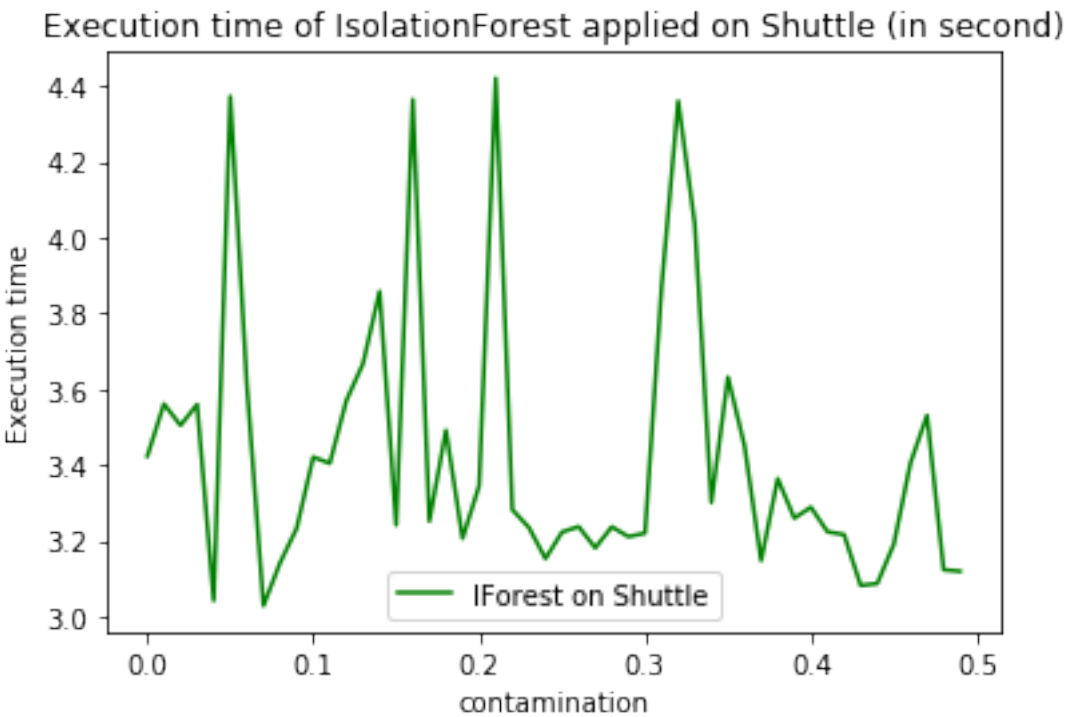
contamination = 0.0
contamination = 0.01
contamination = 0.02
contamination = 0.03
contamination = 0.04
contamination = 0.05
contamination = 0.06
contamination = 0.07
contamination = 0.08
contamination = 0.09
contamination = 0.1
contamination = 0.11
contamination = 0.12
contamination = 0.13
contamination = 0.14
contamination = 0.15
contamination = 0.16
contamination = 0.17
contamination = 0.18
contamination = 0.19
contamination = 0.2
contamination = 0.21
contamination = 0.22
contamination = 0.23
contamination = 0.24
contamination = 0.25
contamination = 0.26
contamination = 0.27
contamination = 0.28
contamination = 0.29
contamination = 0.3
contamination = 0.31
contamination = 0.32
contamination = 0.33
contamination = 0.34
contamination = 0.35000000000000003
contamination = 0.36
contamination = 0.37
contamination = 0.38
contamination = 0.39
contamination = 0.4
contamination = 0.41000000000000003
contamination = 0.42
contamination = 0.43
contamination = 0.44

```
contamination = 0.45
contamination = 0.46
contamination = 0.470000000000000003
contamination = 0.48
contamination = 0.49
```
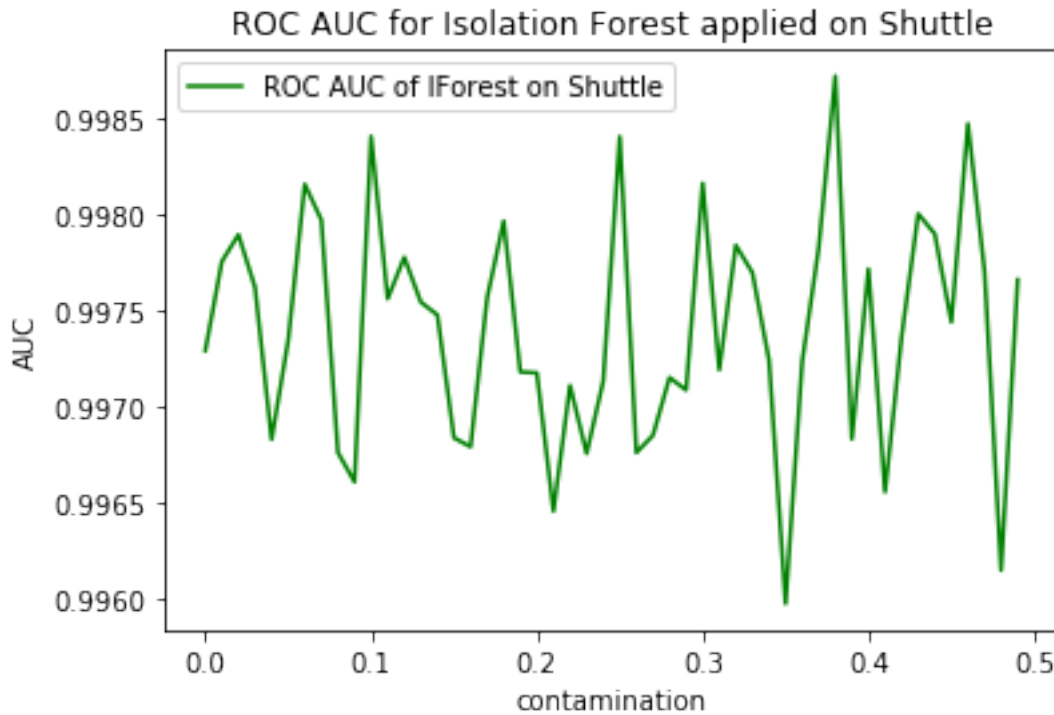
In [39]:

```python
plt.plot(CONT_contamination_IF_Shuttle, CONT_executions_time_I
F_Shuttle,  "g-", label="IForest on Shuttle")
plt.xlabel('contamination')
plt.ylabel('Execution time')
plt.title("Execution time of IsolationForest applied on Shuttl
e (in second)")
plt.legend(loc="best")
plt.show()
```


Execution time of IsolationForest applied on Shuttle (in second)

```python
plt.plot(CONT_contamination_IF_Shuttle, CONT_roc_auc_IF_Shuttl
e,  "g-", label="ROC AUC of IForest on Shuttle")
plt.xlabel('contamination')
plt.ylabel('AUC')
plt.title("ROC AUC for Isolation Forest applied on Shuttle")
plt.legend(loc="best")
plt.show()
```



ROC AUC for Isolation Forest applied on Shuttle

```python
CONT_index = CONT_roc_auc_IF_Shuttle.index(max(CONT_roc_auc_IF
_Shuttle))
print("La meilleure est "+str(max(CONT_roc_auc_IF_Shuttle))+"
pour un temps d'exécution de "+str(CONT_executions_time_IF_Shu
ttle[CONT_index])+"s obtenue avec une contamination de "+str(C
ONT_contamination_IF_Shuttle[CONT_index])+" donnant un rappel
de "+str(CONT_recalls_IF_Shuttle[CONT_index])+" et une spécifi
cité de "+str(CONT_specificity_IF_Shuttle[CONT_index]))
```

La meilleure est 0.9987178355821389 pour un temps
d'exécution de 3.3642470836639404s obtenue avec un
e contamination de 0.38 donnant un rappel de 0.631
9484052121266 et une spécificité de 1.0

```python
# Evolution de spécificité et rappel
plt.plot(CONT_contamination_IF_Shuttle, CONT_recalls_IF_Shuttle, "g-", label="Rappel")
plt.plot(CONT_contamination_IF_Shuttle, CONT_specificity_IF_Shuttle, "b--", label="Spécificité")
plt.title("Courbe Spécificité_Rappel")
#plt.axis([0, 1, 0, 1])
plt.xlabel('contamination')
plt.ylabel('Metrics Value')
plt.legend(loc="best")

plt.show()
```
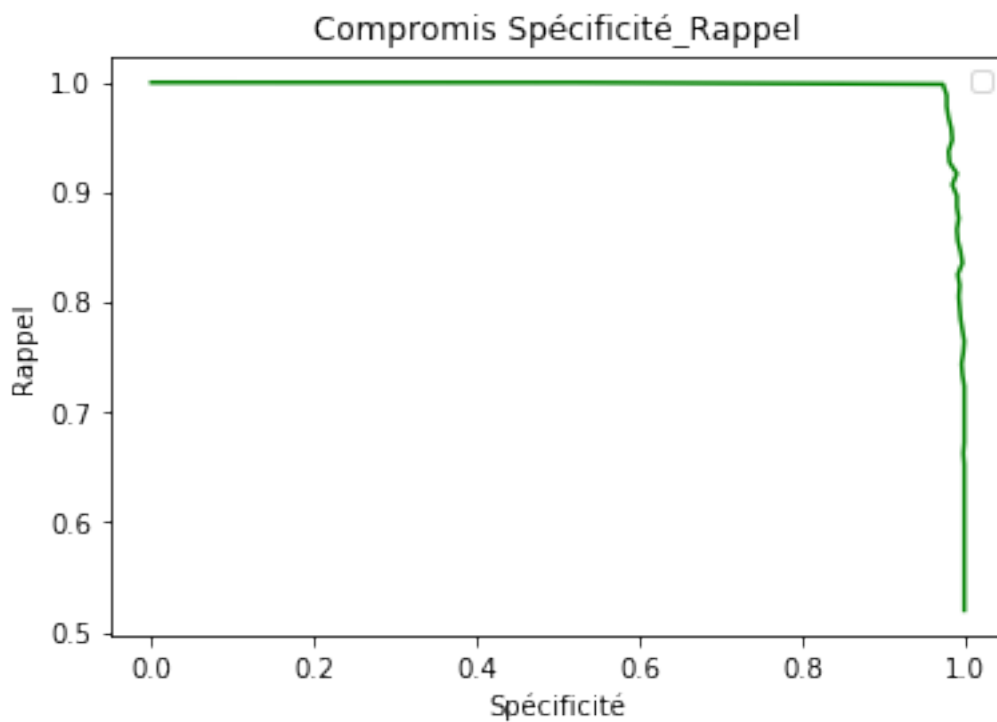

Courbe Spécificité_Rappel

```python
# Evolution de spécificité et rappel
plt.plot(CONT_specificity_IF_Shuttle, CONT_recalls_IF_Shuttle,
"g-")
plt.title("Compromis Spécificité_Rappel")
#plt.axis([0, 1, 0, 1])
plt.xlabel('Spécificité')
plt.ylabel('Rappel')
plt.legend(loc="best")

plt.show()
```
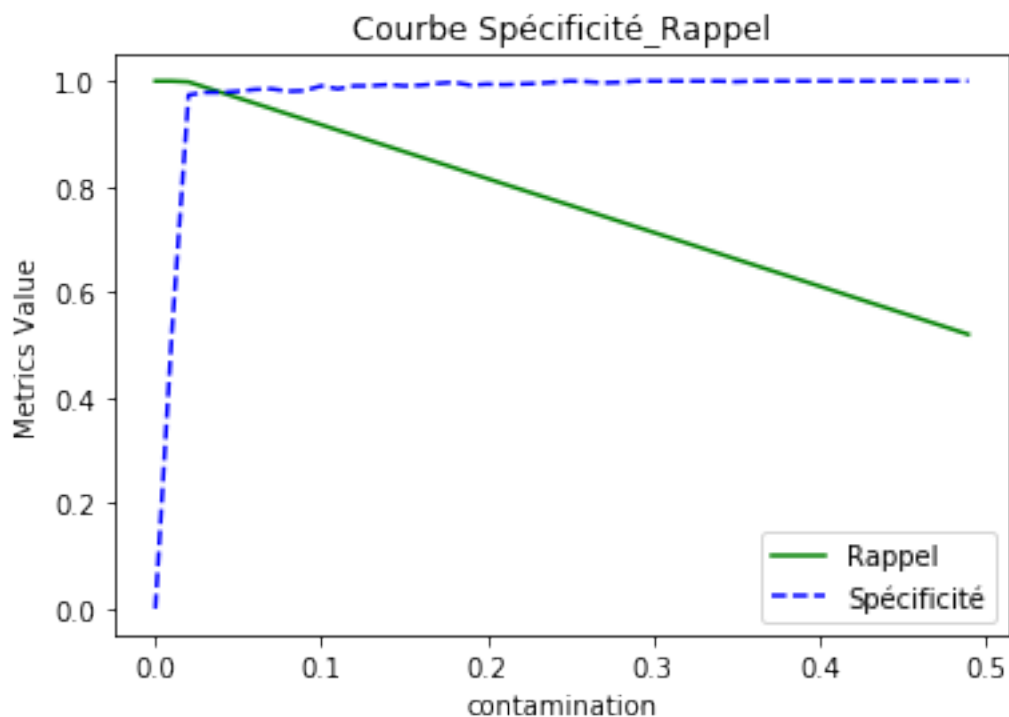
No handles with labels found to put in legend.

Exécution de Isolation Forest sur le jeux de données Shuttle en faisant varier la combinaison entre n_estimators et max_samples

```python
GENE_executions_time_IF_Shuttle = []
GENE_roc_auc_IF_Shuttle = []
GENE_precisions_IF_Shuttle = []
GENE_recalls_IF_Shuttle = []
GENE_f1_scores_IF_Shuttle = []
GENE_tn_IF_Shuttle = []
GENE_fp_IF_Shuttle = []
GENE_fn_IF_Shuttle = []
GENE_tp_IF_Shuttle = []
GENE_specificity_IF_Shuttle = []
GENE_contamination_IF_Shuttle = []


for j in range(5, 1000, 5):
    print("n_estimators = "+str(j))
    n_estimators = j
    for k in range(10, len(X_Shuttle), 100):
        print("max_samples = "+str(k))
        max_samples = k
        start_IF_Shuttle = time()

        # Instanciation, fit and predict on Shuttle
        func_IF_Shuttle = IsolationForest(n_estimators=n_estim
ators, max_samples=max_samples, behaviour="new")
        func_IF_Shuttle.fit(X_Shuttle)
        y_pred_IF_Shuttle = func_IF_Shuttle.predict(X_Shuttle)

        # Calcul du temps d'exécution
        exec_time_IF_Shuttle = time() - start_IF_Shuttle
        executions_time_IF_Shuttle.append(exec_time_IF_Shuttle
)

        # Calcul de l'aire sous la courbe ROC
        auc_IF_Shuttle = roc_auc_score(y_transform_Shuttle, y_
pred_IF_Shuttle)
        roc_auc_IF_Shuttle.append(auc_IF_Shuttle)

        print("Execution time of IsolationForest applied on Sh
uttle (in second)")
        print(executions_time_IF_Shuttle)
        print("ROC AUC for Isolation Forest applied on Shuttle
")
        print(roc_auc_IF_Shuttle)
```

```
n_estimators = 5
```

```
------------------------------------------------------
--------------------------
NameError
Traceback (most recent call last)
<ipython-input-4-3120709be1ca> in <module>
      4         print("n_estimators = "+str(j))
      5         n_estimators = j
----> 6         for k in range(10, len(X_Shuttle), 100
):
      7             print("max_samples = "+str(k))
      8             max_samples = k

NameError: name 'X_Shuttle' is not defined
```

In [ ]:

```python
plt.plot(CONT_contamination_IF_Shuttle, CONT_executions_time_I
F_Shuttle,  "g-", label="IForest on Shuttle")
plt.xlabel('contamination')
plt.ylabel('Execution time')
plt.title("Execution time of IsolationForest applied on Shuttl
e (in second)")
plt.legend(loc="best")
plt.show()
```

In [ ]:

```python
plt.plot(CONT_contamination_IF_Shuttle, CONT_roc_auc_IF_Shuttl
e,  "g-", label="ROC AUC of IForest on Shuttle")
plt.xlabel('contamination')
plt.ylabel('AUC')
plt.title("ROC AUC for Isolation Forest applied on Shuttle")
plt.legend(loc="best")
plt.show()
```

```python
CONT_index = CONT_roc_auc_IF_Shuttle.index(max(CONT_roc_auc_IF
_Shuttle))
print("La meilleure est "+str(max(CONT_roc_auc_IF_Shuttle))+"
pour un temps d'exécution de "+str(CONT_executions_time_IF_Shu
ttle[CONT_index])+"s obtenue avec une contamination de "+str(C
ONT_contamination_IF_Shuttle[CONT_index])+" donnant un rappel
de "+str(CONT_recalls_IF_Shuttle[CONT_index])+" et une spécifi
cité de "+str(CONT_specificity_IF_Shuttle[CONT_index]))
```

```python
# Evolution de spécificité et rappel
plt.plot(CONT_contamination_IF_Shuttle, CONT_recalls_IF_Shuttl
e, "g-", label="Rappel")
plt.plot(CONT_contamination_IF_Shuttle, CONT_specificity_IF_Sh
uttle, "b--", label="Spécificité")
plt.title("Courbe Spécificité_Rappel")
#plt.axis([0, 1, 0, 1])
plt.xlabel('contamination')
plt.ylabel('Metrics Value')
plt.legend(loc="best")

plt.show()
```

```python
# Evolution de spécificité et rappel
plt.plot(CONT_specificity_IF_Shuttle, CONT_recalls_IF_Shuttle,
"g-")
plt.title("Compromis Spécificité_Rappel")
#plt.axis([0, 1, 0, 1])
plt.xlabel('Spécificité')
plt.ylabel('Rappel')
plt.legend(loc="best")

plt.show()
```

```python
print("Execution time of IsolationForest applied on Shuttle (i
n second)")
print(executions_time_IF_Shuttle)
print("La valeur max est "+str(max(executions_time_IF_Shuttle)
)+" à l'index "+str(executions_time_IF_Shuttle.index(max(execu
tions_time_IF_Shuttle))))
plt.plot(np.arange(0., 0.5, 0.00001), executions_time_IF_Shutt
le,  "g-", label="IForest on Shuttle")
plt.xlabel('max_samples')
plt.ylabel('Execution time')
plt.legend(loc="best")
plt.show()
```

```python
print("ROC AUC for Isolation Forest applied on Shuttle")
print(roc_auc_IF_Shuttle)
print("La valeur max est "+str(max(roc_auc_IF_Shuttle))+" à l'
index "+str(roc_auc_IF_Shuttle.index(max(roc_auc_IF_Shuttle)))
)
plt.plot(np.arange(0., 0.5, 0.00001), roc_auc_IF_Shuttle,  "g-
", label="ROC AUC of IForest on Shuttle")
plt.xlabel('max_samples')
plt.ylabel('AUC')
plt.legend(loc="best")
plt.show()
```

Interprétation du résultat de IsolationForest sur Shuttle

Faisant varier n_estimators

L'augmentation du nombre d'arbres augmente le temps d'exécution. L'écart est léger la AUC est aléatoire avec quelques pics.

Meilleure estimation :

```
 - Temps    = 3.8525819778442383
 - ROC AUC = 0.954597443146584 à n_estimators : 80 ==> 1
5 * 5 + 5
```


Faisant varier max_samples

Plus le nombre d'éléments dans l'échantillon augmente, plus le temps d'exécution est long.

Meilleure estimation :

```
 - Temps    = 3.8525819778442383
 - ROC AUC = 0.958660553678761 à max_samples : 1610 ==>
16 * 100 +10
```


Faisant varier contamination

Meilleure combinaison entre n_estimators et max_samples

Meilleure combinaison entre n_estimators et contamination

Meilleure combinaison entre max_samples et contamination

Meilleure combinaison entre max_samples, n_estimators et contamination

Exécution des méthodes avec les meilleurs paramètres trouvés sur Shuttle

In [10]:

```
executions_time_Shuttle = []
```

```python
methods = []

# Isolation Forest avec n_estimators
methods.append('IForest n_estimators')
start_time = time()
n_estimators = 90
func_IF_Shuttle = IsolationForest(n_estimators=n_estimators)
func_IF_Shuttle.fit(X_Shuttle)
y_pred_IF_Shuttle = func_IF_Shuttle.predict(X_Shuttle)
# Calcul du temps d'exécution
executions_time_Shuttle.append(time() - start_time)

# Isolation Forest avec max_samples
methods.append('IForest max_samples')
start_time = time()
max_samples = 2200
func_IF_Shuttle = IsolationForest(max_samples=max_samples)
func_IF_Shuttle.fit(X_Shuttle)
y_pred_IF_Shuttle_max_samples = func_IF_Shuttle.predict(X_Shut
tle)
# Calcul du temps d'exécution
executions_time_Shuttle.append(time() - start_time)

# Isolation Forest avec max_samples et n_estimators
methods.append('IForest max_samples et n_estimators')
start_time = time()
n_estimators = 90
max_samples  = 2200
func_IF_Shuttle = IsolationForest(n_estimators=n_estimators, m
ax_samples=max_samples)
func_IF_Shuttle.fit(X_Shuttle)
y_pred_IF_Shuttle_estimators_samples = func_IF_Shuttle.predict
(X_Shuttle)
# Calcul du temps d'exécution
executions_time_Shuttle.append(time() - start_time)

# OC-SVM
methods.append('OC-SVM')
start_time = time()
nu = 0.4
func_OCSVM_Shuttle = OneClassSVM(nu=nu)
func_OCSVM_Shuttle.fit(X_Shuttle)
y_pred_OCSVM_Shuttle = func_OCSVM_Shuttle.predict(X_Shuttle)
# Calcul du temps d'exécution
executions_time_Shuttle.append(time() - start_time)

# LOF
methods.append('LOF')
```

```
start_time = time()

n_neighbors = 80
func_LOF_Shuttle = LocalOutlierFactor(n_neighbors=n_neighbors,
novelty=True)
func_LOF_Shuttle.fit(X_Shuttle)
y_pred_LOF_Shuttle = func_LOF_Shuttle.predict(X_Shuttle)
# Calcul du temps d'exécution
executions_time_Shuttle.append(time() - start_time)
```

/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:223: FutureWarning:
behaviour="old" is deprecated and will be removed
in version 0.22. Please use behaviour="new", which
makes the decision_function change to match other
anomaly detection algorithm API.
  FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:417: DeprecationWar
ning: threshold_ attribute is deprecated in 0.20 a
nd will be removed in 0.22.
  " be removed in 0.22.", DeprecationWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:223: FutureWarning:
behaviour="old" is deprecated and will be removed
in version 0.22. Please use behaviour="new", which
makes the decision_function change to match other
anomaly detection algorithm API.
  FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:417: DeprecationWar
ning: threshold_ attribute is deprecated in 0.20 a
nd will be removed in 0.22.
  " be removed in 0.22.", DeprecationWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
```

```
version 0.22 to "auto". This will change the predi
ct method behavior.
  FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:223: FutureWarning:
behaviour="old" is deprecated and will be removed
in version 0.22. Please use behaviour="new", which
makes the decision_function change to match other
anomaly detection algorithm API.
  FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:417: DeprecationWar
ning: threshold_ attribute is deprecated in 0.20 a
nd will be removed in 0.22.
  " be removed in 0.22.", DeprecationWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/svm/base.py:196: FutureWarning: The def
ault value of gamma will change from 'auto' to 'sc
ale' in version 0.22 to account better for unscale
d features. Set gamma explicitly to 'auto' or 'sca
le' to avoid this warning.
  "avoid this warning.", FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/neighbors/lof.py:236: FutureWarning: de
fault contamination parameter 0.1 will change in v
ersion 0.22 to "auto". This will change the predic
t method behavior.
  FutureWarning)
```

Calcul des valeurs des métriques de comparaison

In [11]:

```python
precisions_Shuttle = []
recalls_Shuttle = []
roc_aucs_Shuttle = []
f1_scores_Shuttle = []

# Isolation Forest avec n_estimators
# Precision
precisions_Shuttle.append(precision_score(y_transform_Shuttle,
y_pred_IF_Shuttle))
# Recall
recalls_Shuttle.append(recall_score(y_transform_Shuttle, y_pre
d_IF_Shuttle))
# f1_score
f1_scores_Shuttle.append(f1_score(y_transform_Shuttle, y_pred_
```

```python
IF_Shuttle))

# Calcul de l'aire sous la courbe ROC
auc_IF_Shuttle = roc_auc_score(y_transform_Shuttle, y_pred_IF_
Shuttle)
roc_aucs_Shuttle.append(auc_IF_Shuttle)
print("Confusion Matrice IForest avec n_estimators")
print(confusion_matrix(y_transform_Shuttle, y_pred_IF_Shuttle)
)

# Isolation Forest avec max_samples
# Precision
precisions_Shuttle.append(precision_score(y_transform_Shuttle,
y_pred_IF_Shuttle_max_samples))
# Recall
recalls_Shuttle.append(recall_score(y_transform_Shuttle, y_pre
d_IF_Shuttle_max_samples))
# f1_score
f1_scores_Shuttle.append(f1_score(y_transform_Shuttle, y_pred_
IF_Shuttle_max_samples))
# Calcul de l'aire sous la courbe ROC
auc_IF_Shuttle = roc_auc_score(y_transform_Shuttle, y_pred_IF_
Shuttle_max_samples)
roc_aucs_Shuttle.append(auc_IF_Shuttle)
print("Confusion Matrice IForest avec max_samples")
print(confusion_matrix(y_transform_Shuttle, y_pred_IF_Shuttle_
max_samples))

# Isolation Forest avec max_samples et n_estimators
# Precision
precisions_Shuttle.append(precision_score(y_transform_Shuttle,
y_pred_IF_Shuttle_estimators_samples))
# Recall
recalls_Shuttle.append(recall_score(y_transform_Shuttle, y_pre
d_IF_Shuttle_estimators_samples))
# f1_score
f1_scores_Shuttle.append(f1_score(y_transform_Shuttle, y_pred_
IF_Shuttle_estimators_samples))
# Calcul de l'aire sous la courbe ROC
auc_IF_Shuttle = roc_auc_score(y_transform_Shuttle, y_pred_IF_
Shuttle_estimators_samples)
roc_aucs_Shuttle.append(auc_IF_Shuttle)
print("Confusion Matrice IForest avec max_samples et n_estimat
ors")
print(confusion_matrix(y_transform_Shuttle, y_pred_IF_Shuttle_
estimators_samples))

# OC-SVM
# Precision
```

```python
precisions_Shuttle.append(precision_score(y_transform_Shuttle,
y_pred_OCSVM_Shuttle))
# Recall
recalls_Shuttle.append(recall_score(y_transform_Shuttle, y_pre
d_OCSVM_Shuttle))
# f1_score
f1_scores_Shuttle.append(f1_score(y_transform_Shuttle, y_pred_
OCSVM_Shuttle))
# Calcul de l'aire sous la courbe ROC
auc_OCSVM_Shuttle = roc_auc_score(y_transform_Shuttle, y_pred_
OCSVM_Shuttle)
roc_aucs_Shuttle.append(auc_OCSVM_Shuttle)
print("Confusion Matrice OC-SVM")
print(confusion_matrix(y_transform_Shuttle, y_pred_OCSVM_Shutt
le))

# LOF
# Precision
precisions_Shuttle.append(precision_score(y_transform_Shuttle,
y_pred_LOF_Shuttle))
# Recall
recalls_Shuttle.append(recall_score(y_transform_Shuttle, y_pre
d_LOF_Shuttle))
# f1_score
f1_scores_Shuttle.append(f1_score(y_transform_Shuttle, y_pred_
LOF_Shuttle))
# Calcul de l'aire sous la courbe ROC
auc_LOF_Shuttle = roc_auc_score(y_transform_Shuttle, y_pred_LO
F_Shuttle)
roc_aucs_Shuttle.append(auc_LOF_Shuttle)
print("Confusion Matrice LOF")
print(confusion_matrix(y_transform_Shuttle, y_pred_LOF_Shuttle
))
```

```
Confusion Matrice IForest avec n_estimators
[[  864     14]
 [ 3781 41805]]
Confusion Matrice IForest avec max_samples
[[  874      4]
 [ 3773 41813]]
Confusion Matrice IForest avec max_samples et n_es
timators
[[  873      5]
 [ 3774 41812]]
Confusion Matrice OC-SVM
[[  831     47]
 [18058 27528]]
Confusion Matrice LOF
[[  336    542]
 [ 4175 41411]]
```

Présentation des résultats sur Shuttle

Résultat : Temps d'exécution, précision, rappel, score f1, AUC

```python
print("Methods ===>")
print(methods)
print("Execution Time ===>")
print(executions_time_Shuttle)
print("Precision ===>")
print(precisions_Shuttle)
print("Recall ===>")
print(recalls_Shuttle)
print("f1_score ===>")
print(f1_scores_Shuttle)
print("ROC AUC ===>")
print(roc_aucs_Shuttle)
```

```
Methods ===>
['IForest n_estimators', 'IForest max_samples', 'I
Forest max_samples et n_estimators', 'OC-SVM', 'LO
F']
Execution Time ===>
[3.8581349849700928, 5.292931079864502, 5.46475601
1962891, 253.6707808971405, 32.18809700012207]
Precision ===>
[0.9996652239412707, 0.9999043451227969, 0.9998804
314034961, 0.9982955575702629, 0.987080780873835]
Recall ===>
[0.917057868643882, 0.917233361119642, 0.917211424
560172, 0.6038696090905102, 0.9084148642126969]
f1_score ===>
[0.956581431268234, 0.9567863803301946, 0.95676349
7820441, 0.7525320867675401, 0.9461154456870652]
ROC AUC ===>
[0.9505562691738773, 0.9563387762318029, 0.9557583
318700631, 0.775169428691041, 0.6455513956598792]
```

Interprétation des résultats en fonction du Temps d'exécution, précision, rappel, score f1, AUC sur Shuttle

IsolationForest a eu de meilleures performances que les autres. Entre OC-SVM et LOF : OC-SVM a découvert et bien classé plus d'anomalies que LOF. Par contre, LOF a découvert et bien placé plus d'observations normales que OC-SVM. La question est donc de savoir ce qui importe le plus entre la découverte des anomalies et celle des observations normales car c'est en fonction de l'importance que nous donnons à l'un ou à l'autre que nous pourront dire la méthode la

meilleure entre OC-SVM et LOF. Cette question fait remarquer qu'en réalité, toutes les méthodes ont sont performantes dans des conditions données en fonction de ce que l'on souhaite obtenir comme résultat. Dans ce cas précis, OC-SVM lance beaucoup de fausse alertes mais attrappe beaucoup d'anomalies. Par contre, LOF n'attrappe pas beaucoup d'anomalies mais reconnais beaucoup de données normales. On peut peut-être se dire que dans le cas espèce OC-SVM est mieux dans la mesure où une méthode de détection d'anomalies a pour but principal de détecter les anomalies et donc laisser passer des anomalies en ferait une méthode moins bonne et que les observations normales que OC-SVM aurait classé comme anormales sont peut être des nouveautés. Considérant l'aire sous la courbe ROC, nous avons l'ordre suivant IForest - OC-SVM et LOF

Tableau du résultat TOBC = VN/(VN + FP) TNBC = VP/(FN + VP)

Méthode	Précision	Rappel	Score f1	AUC	TOBC	TNBC	CPU Time
IForest n	0.9996652	0.9170578	0.95658143	0.9505562	0.9840546	0.9170578	3.8581349
IForest max	0.9999043	0.9172333	0.95678638	0.9563387	0.9954444	0.9172334	5.2929310
IForest n et max	0.9998804	0.9172114	0.95676349	0.9557583	0.9943052	0.9172114	5.4647560
OC-SVM	0.9982955	0.6038696	0.75253208	0.7751694	0.9464692	0.6038696	253.67078
LOF	0.9870807	0.9084148	0.94611544	0.6455514	0.3826879	0.9084149	32.188097

Resultat: Courbe ROC pour Shuttle

```
In [14]:
```

```
fpr_IF_Shuttle, tpr_IF_Shuttle, thresholds_IF_Shuttle = roc_cu
rve(y_transform_Shuttle, y_pred_IF_Shuttle)
fpr_IF_Shuttle_max_samples, tpr_IF_Shuttle_max_samples, thresh
olds_IF_Shuttle_max_samples = roc_curve(y_transform_Shuttle, y
_pred_IF_Shuttle_max_samples)
fpr_IF_Shuttle_estimators_samples, tpr_IF_Shuttle_estimators_s
amples, thresholds_IF_Shuttle_estimators_samples = roc_curve(y
_transform_Shuttle, y_pred_IF_Shuttle_estimators_samples)
fpr_LOF_Shuttle, tpr_LOF_Shuttle, thresholds_LOF_Shuttle = roc
_curve(y_transform_Shuttle, y_pred_LOF_Shuttle)
fpr_OCSVM_Shuttle, tpr_OCSVM_Shuttle, thresholds_OCSVM_Shuttle
= roc_curve(y_transform_Shuttle, y_pred_OCSVM_Shuttle)
```

```
In [15]:
```

```
plt.plot(fpr_IF_Shuttle, tpr_IF_Shuttle, "g-", label="IForest"
)
plt.plot(fpr_LOF_Shuttle, tpr_LOF_Shuttle, "b--", label="LOF")
plt.plot(fpr_OCSVM_Shuttle, tpr_OCSVM_Shuttle, "r-", label="OC
-SVM")
plt.plot([0, 1], [0, 1], 'k--')
plt.axis([0, 1, 0, 1])
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.legend(loc="lower right")

plt.show()
```
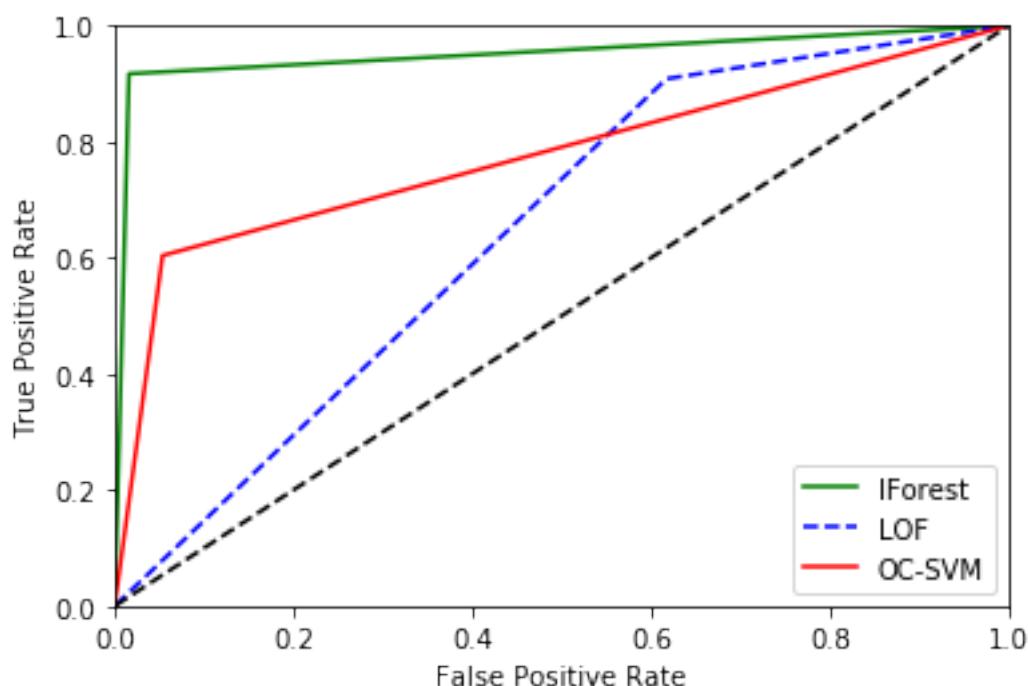
In [16]:

```python
plt.plot(fpr_IF_Shuttle, tpr_IF_Shuttle, "g-", label="IForest")
plt.plot(fpr_IF_Shuttle_max_samples, tpr_IF_Shuttle_max_samples, "k-", label="IForest Max_Samples")
plt.plot(fpr_IF_Shuttle_estimators_samples, tpr_IF_Shuttle_estimators_samples, "g--", label="IForest Estimators et Samples")
plt.plot(fpr_LOF_Shuttle, tpr_LOF_Shuttle, "b--", label="LOF")
plt.plot(fpr_OCSVM_Shuttle, tpr_OCSVM_Shuttle, "r-", label="OC-SVM")
plt.plot([0, 1], [0, 1], 'k--')
plt.axis([0, 1, 0, 1])
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.legend(loc="lower right")

plt.show()
```
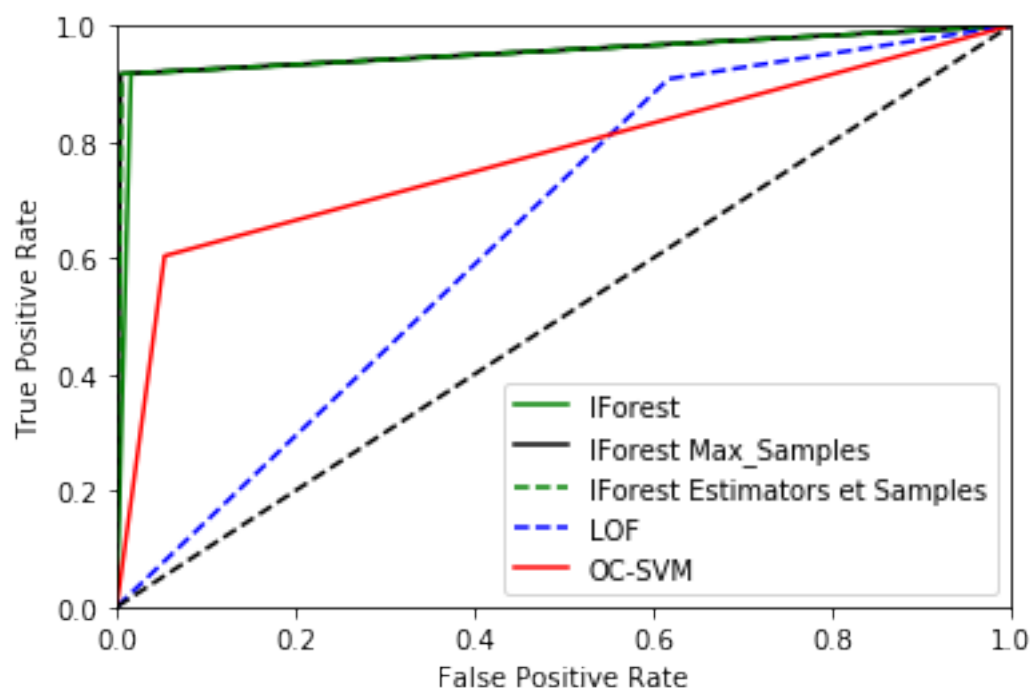
Interprétation de la courbe ROC

La courbe ROC mesurant le taux de faux positif par rapport au taux de vrai positif, plus la courbe s'éloigne de celle oblique en noir, mieux c'est. Ainsi, on peut dire que pour Shuttle, IForest est la meilleure méthode de détection d'anomalies suivi par OC-SVM. Le classement de LOF pourrait s'expliquer par le fait que les anomalies qui y sont présentes sont des anomalies global alors que LOF est doué pour les anomalies locales. POur vérifier ça peut être qu'on peut utiliser une méthode de clustering comme K-means pour voir comment les anomalies seront classées par cette méthode.

Conclusion Shuttle

Pour un jeu de données statique de faible dimension, Isolation forest a tendance à mieux performer et semble être plus rapide que OC-SVM et LOF. OC-SVM détecte beaucoup d'anomalies avec un fort taux de fausses alertes et un temps d'exécution plus grand que LOF. Par contre, LOF détecte moins d'anomalies avec un faible taux de fausses alertes. Notons que la performance des méthodes dépends non seulement du jeu de données considéré mais aussi des valeurs des hypermaramètres. Pour LOF et IsolationForest, le temps d'exécution semble être en correlation positive avec respectivement le nombre de voisins et nombre de d'estimateurs. Par contre, le temps d'exécution serait en correlation négative avec nu.

In [ ]: