

# Comparaison de LOF, OC-SVM et Isolation Forest

## Jeux de données

Nous utilisons deux jeux de données Shuttle et KDD-Cup99 HTTP

## Algorithmes comparées

Nous comparons LOF, OC-SVM et Isolation Forest qui sont des méthodes non supervisées de détection d'anomalies Pour chacune de ces méthodes,

- Nous utilisons l'implémentation faite par scikit-learn
- Nous les initialisons avec les valeurs par défaut
- Pour chaque méthode, nous faisons varier un paramètre et exécutons la méthode sur le jeu de données un certain nombre (x) de fois.
- La moyenne des x temps d'exécution et de AUC donne la valeur à considérer pour cette valeur de paramètre concernant cette méthode.
  - Isolation Forest : Contamination (0 à 0,5 pas de 0,1) ----Plutôt faire varier n\_estimators (50 à 300 pas de 10)----
  - OC-SVM : nu (0,1 à 1 pas de 0,1) comme dans Goldein et Uchida
  - LOF : n\_neighbors (5 à 200 pas de 5) comme dans Goldein et Uchida
- Ceci permet de connaître pour chaque algorithme la valeur du paramètre le plus important qui permet d'avoir le meilleur résultat.
- La courbe ROC sera alors dessinée pour toutes les méthodes ensemble en utilisant leur meilleur paramètres.
- Un tableau sera fait pour comparer le temps d'exécution moyen, la précision moyenne, la AUC moyenne, le rappel moyen des méthodes sur chaque jeu de données.
- Les interprétations seront données pour chaque méthode à propos de chaque jeu de données et pour tous les jeux de données par la suite.

NB: On ne peut pas dessiner la courbe des AUCs comme dans Goldein et Uchida parce que les méthodes qu'ils ont comparé ont des paramètres en commun notamment les méthodes basées sur les plus proche voisins. Ce qui fait qu'ils ont pu tracer la courbe des AUCs en faisant varier le nombre de voisins et comparer les performances des méthodes entre elle. Dans notre cas, ces trois méthodes n'ont rien en commun pour un tel exercice.

## Métriques de comparaison

Nous comparons ces méthodes sur la base du temps d'exécution et sur la base de l'air sous la courbe ROC (ROC AUC)

- Nous calculons le temps d'exécution de la fonction sur ces jeux de données avec la fonction time() que nous appelons avant de lancer l'initialisation de la méthode pour avoir l'heure de début. Nous appelons encore la fonction time() à la fin de l'exécution de la fonction predict() de la méthode pour avoir l'heure

de fin du traitement. La différence entre ces deux moments nous donne le temps d'exécution de la méthode en secondes (s)

- Nous calculons l'aire sous la courbe ROC avec la fonction `roc_auc_score()` de `scikit-learn`
- La précision
- Le rappel
- Le score f1
- la courbe ROC ##### Temps d'exécution Le temps d'exécution est le temps qui sépare le lancement de la méthode à la fin de sa prédiction. Ceci permettra d'évaluer les différentes méthodes en fonction de temps qu'elles prennent pour classer les observations dans le dataset en anomalies ou normales. Il sera tenu compte du fait que le temps d'exécution peut être fonction du type du jeu de données de la taille du jeu de données et du nombre de dimension. ##### Précision ()

$$TP / (TP + FP)$$

Le taux d'observations classées positives (ici normale) par la méthode par rapport à toutes les observations réellement normales ##### Rappel (TPR)

$$TP / (TP + FN)$$

C'est le taux d'observations positives (ici normale) ayant été correctement détectées par la méthode. ##### Score f1

$$2 * TP / (TP + (FN + FP) / 2)$$

F1 est la moyenne harmonique de la précision et du rappel. F1 donne plus de poids aux faibles valeurs et est donc utile pour comparer deux méthodes de classification

##### Courbe ROC

O = Outlier = Négatif N = Normal = Positif

---

O | N

---

O | VN | FP

---

N | FN | VP

## ROC AUC

In [1]:

```
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
```

## 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.

In [2]:

```
data_brut_Shuttle = pd.read_csv('/Users/thesard/Doctorat/These 2018/ISEP/Developpements/EspaceIntelliJ/LearningAllInPython/Learning_IHM_Features/datasets/imported_datasets/shuttle-unsupervised-ad_2019-06-14 17:33:02.493755.csv', header=None, index_col=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[2]:

	0	1	2	3	4
count	46464.000000	46464.000000	46464.000000	46464.000000	46464.000000
mean	44.775482	-0.712509	84.834108	0.279291	3.000000
std	8.753404	44.218007	8.731175	37.317203	1.000000
min	27.000000	-4475.000000	21.000000	-3939.000000	-18.000000
25%	37.000000	0.000000	79.000000	0.000000	3.000000
50%	43.000000	0.000000	83.000000	0.000000	4.000000
75%	49.000000	0.000000	87.000000	0.000000	4.000000
max	123.000000	1963.000000	149.000000	3830.000000	49.000000

## 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.

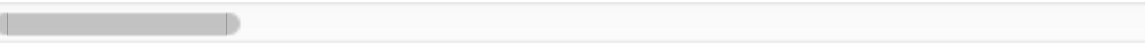
In [3]:

```
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[3]:

	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 x 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.

In [4]:

```
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**

In [5]:

```
max_samples = 'auto'

averages_executions_time_IF_Shuttle = []
averages_roc_auc_IF_Shuttle = []

for j in range(10, 300, 10):
    n_estimators = j
    executions_time_IF_Shuttle = []
    roc_auc_IF_Shuttle = []
    for i in range(5):
        start_IF_Shuttle = time()

        func_IF_Shuttle = IsolationForest(n_estimators=n_estimators, max_samples=max_samples)
        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("ROC AUC for Isolation Forest applied on Shuttle")

    #print(roc_auc_IF_Shuttle)
    print("Execution time of IsolationForest applied on Shuttle (in second)")
    print(executions_time_IF_Shuttle)
    print("ROC AUC for Isolation Forest applied on Shuttle")
    print(roc_auc_IF_Shuttle)
    averages_executions_time_IF_Shuttle.append(statistics.mean(executions_time_IF_Shuttle))
    averages_roc_auc_IF_Shuttle.append(statistics.mean(roc_auc_IF_Shuttle))
```

/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)

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Execution time of IsolationForest applied on Shuttle (in second)

```
[0.43103790283203125, 0.4355888366699219, 0.4150211811065674, 0.5610771179199219, 0.5112731456756592]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9529767611384505, 0.9499758248121375, 0.9563607127912728, 0.9531412853344756, 0.9505562691738773]
```

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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[1.1420910358428955, 0.9584560394287109, 0.7817699
909210205, 0.859246015548706, 0.8621351718902588]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9551778875083238, 0.9540169987848446, 0.9505343
326144072, 0.9551778875083238, 0.9528561100613655]
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Execution time of IsolationForest applied on Shuttle (in second)

```
[1.2591259479522705, 1.173518180847168, 1.09661221
50421143, 1.4128477573394775, 1.6369400024414062]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9563387762318029, 0.9499538882526675, 0.9493734
43890928, 0.9505453008941421, 0.9511147769761468]
```

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" be removed in 0.22.", DeprecationWarning)
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Execution time of IsolationForest applied on Shuttle (in second)  
[2.034435987472534, 1.726597785949707, 1.6513590812683105, 2.08528995513916, 1.5280189514160156]  
ROC AUC for Isolation Forest applied on Shuttle  
[0.9580801093170214, 0.9534365544231049, 0.9511257452558817, 0.9487929995291885, 0.9512463963329668]

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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[1.9374489784240723, 1.7611498832702637, 1.9203009605407715, 1.8109049797058105, 1.8666479587554932]

ROC AUC for Isolation Forest applied on Shuttle

[0.9580801093170214, 0.9528561100613655, 0.9522756656996257, 0.9517061896176212, 0.9534365544231049]

/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.

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/Users/thesard/anaconda3/lib/python3.7/site-pack
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[2.131838321685791, 2.1302242279052734, 2.45739412
30773926, 2.460753917694092, 2.288135051727295]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9517061896176212, 0.9511147769761468, 0.9476321
108057093, 0.9528561100613655, 0.9505343326144072]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-pack
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" be removed in 0.22.", DeprecationWarning)
```

```
Execution time of IsolationForest applied on Shutt
le (in second)
[2.5886881351470947, 2.6734941005706787, 2.6824829
57839966, 2.7809369564056396, 3.1526501178741455]
ROC AUC for Isolation Forest applied on Shuttle
[0.9534365544231049, 0.9522756656996257, 0.9522756
656996257, 0.9487929995291885, 0.9476321108057093]
```

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Execution time of IsolationForest applied on Shuttle (in second)

[3.6802477836608887, 2.9864070415496826, 3.107619047164917, 2.9581282138824463, 2.9837841987609863]

ROC AUC for Isolation Forest applied on Shuttle

[0.9499538882526675, 0.9516952213378863, 0.9511147769761468, 0.9528561100613655, 0.9516952213378863]

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Execution time of IsolationForest applied on Shuttle (in second)

[3.375458240509033, 3.204303026199341, 3.1923539638519287, 3.2720258235931396, 3.199881076812744]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9569192205935423, 0.9551778875083238, 0.9505343326144072, 0.954597443146584]

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```
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```

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```

```
" be removed in 0.22.", DeprecationWarning)
```

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

```
[3.7040088176727295, 3.809349775314331, 3.67948698
99749756, 3.80515193939209, 4.868165016174316]
```

```
ROC AUC for Isolation Forest applied on Shuttle
```

```
[0.9505343326144072, 0.9516952213378863, 0.9516952
213378863, 0.954597443146584, 0.9505343326144072]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-pack
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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[6.007195711135864, 5.387622356414795, 4.625060796737671, 4.832353830337524, 5.600948095321655]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528670783411003, 0.9528670783411003, 0.9522756656996257, 0.9511147769761468, 0.9569192205935423]

/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.

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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.613799095153809, 4.643831014633179, 5.371103048324585, 4.4284749031066895, 4.740011215209961]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9557583318700631, 0.9511147769761468, 0.9528561100613655, 0.9499538882526675, 0.9511147769761468]
```

```
/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.
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FutureWarning)
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```

```
" be removed in 0.22.", DeprecationWarning)
```

```
Execution time of IsolationForest applied on Shuttle (in second)
```

```
[5.429809093475342, 5.4301769733428955, 6.485217094421387, 5.199697971343994, 5.5244300365448]
```

```
ROC AUC for Isolation Forest applied on Shuttle
```

```
[0.9528561100613655, 0.9499648565324026, 0.9522756656996257, 0.9569192205935423, 0.9540169987848446]
```

```
/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.
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FutureWarning)
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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.417048931121826, 5.985644102096558, 5.399899005
889893, 5.4616498947143555, 5.768394947052002]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9505453008941421, 0.9528561
100613655, 0.9511147769761468, 0.949373443890928]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-pack
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FutureWarning)
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```
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Execution time of IsolationForest applied on Shutt
le (in second)
[7.145005226135254, 5.693637132644653, 5.306113004
684448, 5.2800257205963135, 5.891430139541626]
ROC AUC for Isolation Forest applied on Shuttle
[0.9522756656996257, 0.9511147769761468, 0.9499538
882526675, 0.9534365544231049, 0.9528561100613655]
```

```
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Execution time of IsolationForest applied on Shutt
le (in second)
[6.699141025543213, 7.057630777359009, 9.505704164
505005, 6.221740961074829, 7.797239065170288]
ROC AUC for Isolation Forest applied on Shuttle
[0.9511147769761468, 0.9511147769761468, 0.9516952
213378863, 0.9540169987848446, 0.949373443890928]
```

```
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Execution time of IsolationForest applied on Shuttle (in second)

[6.288877248764038, 6.260418891906738, 6.222504138946533, 6.704073905944824, 6.96709680557251]

ROC AUC for Isolation Forest applied on Shuttle

[0.9499538882526675, 0.9522756656996257, 0.9516952213378863, 0.9528561100613655, 0.9528561100613655]

/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.

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Execution time of IsolationForest applied on Shuttle (in second)

[7.480480194091797, 7.084450006484985, 6.619936943054199, 6.802766799926758, 6.442012071609497]

ROC AUC for Isolation Forest applied on Shuttle

[0.9516952213378863, 0.9511147769761468, 0.9522756656996257, 0.9534365544231049, 0.9511147769761468]

/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.

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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.146161794662476, 7.275901794433594, 7.184439182
281494, 7.0973358154296875, 6.747941970825195]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9511147769761468, 0.9499538
882526675, 0.9528561100613655, 0.9540169987848446]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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Execution time of IsolationForest applied on Shuttle (in second)

```
[7.219103097915649, 8.352814197540283, 7.578938007354736, 7.480122804641724, 7.699251413345337]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9511147769761468, 0.9516952213378863, 0.9528561100613655, 0.9516952213378863, 0.9522756656996257]
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/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.
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```

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

```
[7.977267026901245, 7.974909067153931, 7.759855747
2229, 7.896172046661377, 8.195299863815308]
```

```
ROC AUC for Isolation Forest applied on Shuttle
```

```
[0.9516952213378863, 0.9505343326144072, 0.9516952
213378863, 0.9522756656996257, 0.9522756656996257]
```

```
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```
" be removed in 0.22.", DeprecationWarning)
```

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

```
[9.203197717666626, 9.351696252822876, 8.598716020
584106, 10.346078872680664, 9.384166955947876]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9528561100613655, 0.9534365
544231049, 0.9505343326144072, 0.9522756656996257]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[11.22852087020874, 11.436401128768921, 11.66942572593689, 13.157791137695312, 10.030635118484497]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.954597443146584, 0.9534365544231049, 0.9522756656996257, 0.9511147769761468]

/Users/thesard/anaconda3/lib/python3.7/site-packag

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nd will be removed in 0.22.
    " be removed in 0.22.", DeprecationWarning)
```

```
Execution time of IsolationForest applied on Shuttle (in second)
[12.493605136871338, 11.744182825088501, 12.41071891784668, 9.858978748321533, 10.652988910675049]
ROC AUC for Isolation Forest applied on Shuttle
[0.9516952213378863, 0.9534365544231049, 0.9511147769761468, 0.9540169987848446, 0.9528561100613655]
```

```
/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.
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```
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Execution time of IsolationForest applied on Shuttle (in second)

[9.929949045181274, 11.447458744049072, 10.070409774780273, 9.06134295463562, 9.069718837738037]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9534365544231049, 0.9534365544231049, 0.9528561100613655, 0.9522756656996257]

/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.

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FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-pack
```

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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[9.331416845321655, 9.39087986946106, 9.2072699069
9768, 10.14323616027832, 9.273991107940674]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9528561100613655, 0.9516952
213378863, 0.9522756656996257, 0.9534365544231049]
```

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FutureWarning)
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/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)

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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[9.798256874084473, 9.5221266746521, 9.86213207244
873, 9.613476037979126, 9.662375211715698]
ROC AUC for Isolation Forest applied on Shuttle
[0.9511147769761468, 0.9505343326144072, 0.9528561
100613655, 0.9516952213378863, 0.9516952213378863]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-pack
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[10.641808986663818, 12.402535915374756, 11.571316
957473755, 10.416658878326416, 9.831680059432983]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9511147769761468, 0.9522756656996257, 0.9516952
213378863, 0.9516952213378863, 0.9511147769761468]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-pack
ages/sklearn/ensemble/iforest.py:213: FutureWarn
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```
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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[10.692094802856445, 11.535588026046753, 19.43449091911316, 12.972423315048218, 14.10976791381836]

ROC AUC for Isolation Forest applied on Shuttle

[0.949373443890928, 0.9516952213378863, 0.9511147769761468, 0.9522756656996257, 0.9516952213378863]

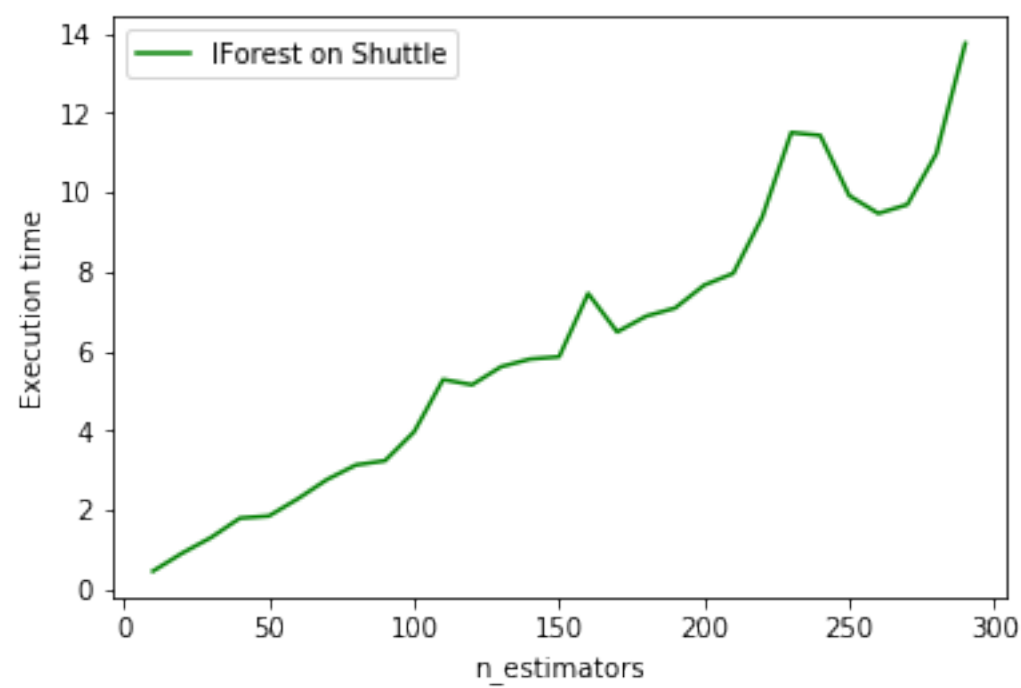
## Résultat de Isolation Forest sur Shuttle

In [7]:

```
print("Execution time of IsolationForest applied on Shuttle (in second)")
print(averages_executions_time_IF_Shuttle)
plt.plot(range(10, 300, 10), averages_executions_time_IF_Shuttle, "g-", label="IForest on Shuttle")
#plt.axis([0, 1, 0, 1])
plt.xlabel('n_estimators')
plt.ylabel('Execution time')
plt.legend(loc="best")
plt.show()
```

Execution time of IsolationForest applied on Shuttle (in second)

[0.4707996368408203, 0.9207396507263184, 1.3158088207244873, 1.8051403522491456, 1.8592905521392822, 2.2936691284179687, 2.775650453567505, 3.143237257003784, 3.2488044261932374, 3.9732325077056885, 5.290636157989502, 5.1594438552856445, 5.613866233825684, 5.806527376174927, 5.863242244720459, 7.456291198730469, 6.488594198226929, 6.885929203033447, 7.090356111526489, 7.666045904159546, 7.960700750350952, 9.376771163940429, 11.504554796218873, 11.43209490776062, 9.915775871276855, 9.469358777999878, 9.691673374176025, 10.972800159454346, 13.748872995376587]



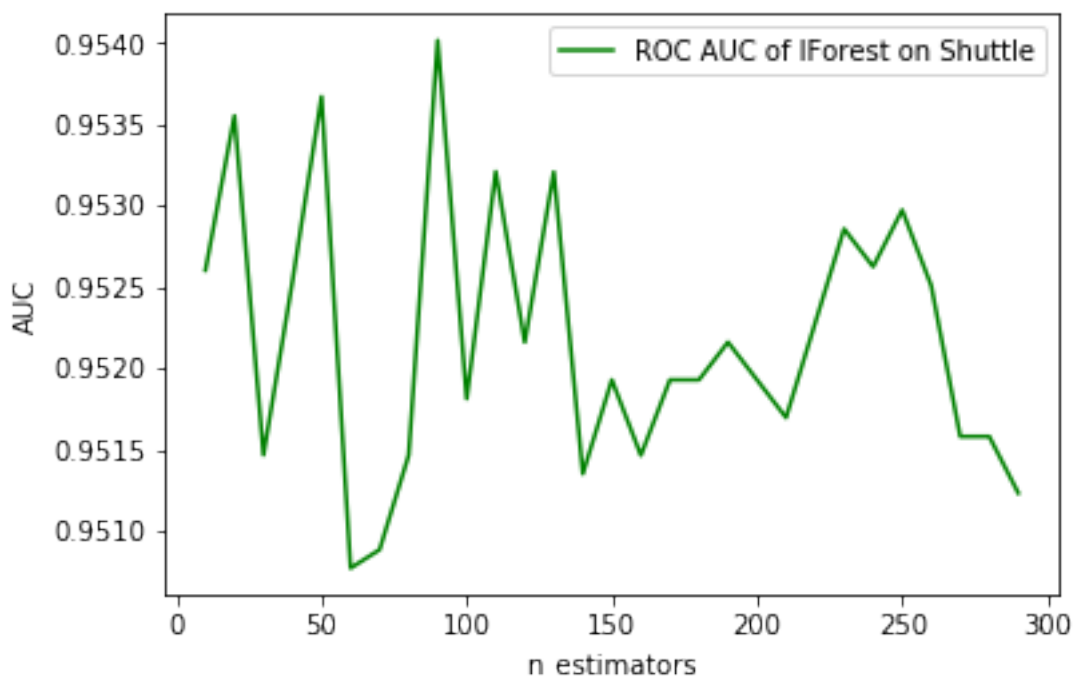
In [8]:

```
print("ROC AUC for Isolation Forest applied on Shuttle")
print(averages_roc_auc_IF_Shuttle)
print("La valeur max est "+str(max(averages_roc_auc_IF_Shuttle
))+ " à l'index "+str(averages_roc_auc_IF_Shuttle.index(max(ave
rages_roc_auc_IF_Shuttle))))
plt.plot(range(10, 300, 10), averages_roc_auc_IF_Shuttle, "g-
", label="ROC AUC of IForest on Shuttle")
#plt.axis([0, 1, 0, 1])
plt.xlabel('n_estimators')
plt.ylabel('AUC')
plt.legend(loc="best")
plt.show()
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9526021706500427, 0.953552643295453, 0.95146523
72491375, 0.9525363609716326, 0.9536709258237478,
0.95076870401505, 0.9508825992314508, 0.9514630435
931904, 0.9540169987848446, 0.9518113102102342, 0.
9532087639903031, 0.9521595768272779, 0.9532065703
343562, 0.9513491483767896, 0.9519273990825821, 0.
9514630435931904, 0.9519273990825821, 0.9519273990
825821, 0.9521595768272779, 0.9519273990825822, 0.
9516952213378863, 0.9522756656996259, 0.9528561100
613654, 0.9526239323166696, 0.9529721989337133, 0.
9525078434443216, 0.9515791324655384, 0.9515791324
655384, 0.9512308658484946]
```

La valeur max est 0.9540169987848446 à l'index 8



# Exécution de Isolation Forest sur le jeux de données Shuttle en faisant varier max\_samples

In [5]:

```
max_samples = 'auto'

averages_executions_time_IF_Shuttle = []
averages_roc_auc_IF_Shuttle = []

for j in range(100, len(X_Shuttle), 100):
    max_samples = j
    executions_time_IF_Shuttle = []
    roc_auc_IF_Shuttle = []
    for i in range(5):
        start_IF_Shuttle = time()

        func_IF_Shuttle = IsolationForest(max_samples=max_samp
les)

        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("ROC AUC for Isolation Forest applied on Shuttl
e")

        #print(roc_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)
        averages_executions_time_IF_Shuttle.append(statistics.mean
(executions_time_IF_Shuttle))
        averages_roc_auc_IF_Shuttle.append(statistics.mean(roc_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 predict method behavior.

```
FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packages/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.
```

```
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```
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```
FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
```



```
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```
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```
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```

```
    " be removed in 0.22.", DeprecationWarning)
```

```
Execution time of IsolationForest applied on Shuttle (in second)
```

```
[3.191356897354126, 3.0212759971618652, 3.42480206489563, 3.7226619720458984, 4.378544092178345]
```

```
ROC AUC for Isolation Forest applied on Shuttle
```

```
[0.9487929995291885, 0.9487929995291885, 0.9476321108057093, 0.9482125551674488, 0.9487929995291885]
```

/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.

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```
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```
FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:417: DeprecationWarning: threshold_ attribute is deprecated in 0.20 and will be removed in 0.22.
```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)  
[4.291905164718628, 3.3072378635406494, 3.2773401737213135, 4.658457040786743, 4.078073978424072]  
ROC AUC for Isolation Forest applied on Shuttle  
[0.9522756656996257, 0.9511147769761468, 0.9505343326144072, 0.9528561100613655, 0.9499538882526675]

/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.

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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[4.517627716064453, 4.502696990966797, 3.711866855621338, 4.190847158432007, 4.437525987625122]

ROC AUC for Isolation Forest applied on Shuttle

[0.9516952213378863, 0.954597443146584, 0.9551778875083238, 0.9487929995291885, 0.9563387762318029]

/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.

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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[3.301737070083618, 3.1620731353759766, 3.3190951347351074, 3.403571128845215, 3.3013248443603516]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9540169987848446, 0.9563387762318029, 0.9528561100613655, 0.9551778875083238]
```

```
/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)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/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.
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FutureWarning)
```

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FutureWarning)
```

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```
FutureWarning)
```

```
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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[3.4346981048583984, 3.396077871322632, 3.403640031814575, 3.453742742538452, 3.516235113143921]

ROC AUC for Isolation Forest applied on Shuttle

[0.9569192205935423, 0.9574996649552819, 0.9563497445115378, 0.9574996649552819, 0.9557583318700631]

/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.

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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[4.269500255584717, 3.620023012161255, 3.8123650550842285, 3.505950927734375, 3.803757905960083]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9557583318700631, 0.9540169987848446, 0.9569192205935423, 0.9557583318700631, 0.9563387762318029]
```

```
/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.
```

```
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```
FutureWarning)
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```

```
FutureWarning)
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```

```
FutureWarning)
```

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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[3.9891598224639893, 3.6721549034118652, 4.020142078399658, 3.5334577560424805, 3.6908700466156006]

ROC AUC for Isolation Forest applied on Shuttle

[0.9540169987848446, 0.9563387762318029, 0.958660553678761, 0.9563387762318029, 0.9563387762318029]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[3.577437162399292, 3.759087085723877, 3.7026288509368896, 3.453348159790039, 3.467740297317505]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9540169987848446, 0.9557693001497983, 0.9563387762318029, 0.9522756656996257, 0.9557583318700631]
```

```
/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.
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```
FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packages/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.
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[3.938145875930786, 3.592602014541626, 3.804643154144287, 3.439552068710327, 3.4891719818115234]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9569192205935423, 0.9551778875083238, 0.9580801093170214, 0.958660553678761, 0.9569301888732772]
```

```
/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.
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```
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/Users/thesard/anaconda3/lib/python3.7/site-packag
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[3.415760040283203, 3.4881107807159424, 4.17971301
0787964, 4.139667987823486, 4.162909984588623]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9563387762318029, 0.9563387762318029, 0.9569192
205935423, 0.9580801093170214, 0.9563387762318029]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```
" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[4.258279800415039, 4.887712001800537, 4.395806074
142456, 4.682211875915527, 5.269437074661255]
ROC AUC for Isolation Forest applied on Shuttle
[0.9574996649552819, 0.958660553678761, 0.95459744
3146584, 0.9563387762318029, 0.9557583318700631]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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Execution time of IsolationForest applied on Shuttle (in second)

[4.355852127075195, 3.762460231781006, 3.6737630367279053, 3.740324020385742, 3.7497239112854004]

ROC AUC for Isolation Forest applied on Shuttle  
[0.954597443146584, 0.9563387762318029, 0.9563387762318029, 0.9569192205935423, 0.9563387762318029]

/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.

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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[4.200876951217651, 4.531267881393433, 4.660983085
632324, 4.425206184387207, 4.185022830963135]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9574996649552819, 0.958660553678761, 0.95633877
62318029, 0.957510633235017, 0.9557583318700631]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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FutureWarning)
```

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FutureWarning)
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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[3.8413331508636475, 3.8215792179107666, 3.767184257507324, 4.476852893829346, 4.525475978851318]

ROC AUC for Isolation Forest applied on Shuttle

[0.9569301888732772, 0.958660553678761, 0.9569192205935423, 0.9563387762318029, 0.9580801093170214]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[4.021965026855469, 4.0086469650268555, 3.871774911880493, 3.848217010498047, 3.861248016357422]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9534365544231049, 0.9574996649552819, 0.958660553678761, 0.9574996649552819, 0.9580801093170214]
```

```
/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.
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[3.8828351497650146, 3.8447201251983643, 3.9042940
13977051, 3.9178929328918457, 3.9354748725891113]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9569192205935423, 0.9563387762318029, 0.9563387
762318029, 0.9563387762318029, 0.958660553678761]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[4.225378036499023, 3.9831080436706543, 3.9375951290130615, 3.8581790924072266, 3.867215156555176]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9569192205935423, 0.9563387762318029, 0.9557583318700631, 0.9551778875083238, 0.9563387762318029]
```

```
/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.
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[3.742002248764038, 3.7297558784484863, 3.732529878616333, 3.7108852863311768, 3.8110039234161377]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9563387762318029, 0.9557583318700631, 0.9569192205935423, 0.9569192205935423, 0.9569192205935423]
```

```
/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.
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```
FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[3.755141019821167, 4.267197132110596, 4.703334808
349609, 4.205974102020264, 3.7100448608398438]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9563387762318029, 0.9574996649552819, 0.9575106
33235017, 0.958660553678761, 0.9563387762318029]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[3.7737958431243896, 3.6848251819610596, 3.658151149749756, 3.6624209880828857, 3.6469812393188477]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9563387762318029, 0.9569192205935423, 0.9528561100613655, 0.9563387762318029, 0.9569192205935423]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in
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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[3.9449779987335205, 3.976369857788086, 3.9603419303894043, 4.454745054244995, 3.943197727203369]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9563387762318029, 0.9569192205935423, 0.9569192205935423, 0.9580910775967564, 0.9563387762318029]
```

```
/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 predict method behavior.

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nd will be removed in 0.22.
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```

Execution time of IsolationForest applied on Shuttle (in second)  
[3.9451510906219482, 3.99711275100708, 4.01582407951355, 3.9222028255462646, 3.883847236633301]  
ROC AUC for Isolation Forest applied on Shuttle  
[0.9580801093170214, 0.9569192205935423, 0.9569192205935423, 0.958660553678761, 0.9569192205935423]

/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.

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Execution time of IsolationForest applied on Shuttle (in second)

[3.972074031829834, 3.949953079223633, 3.9969561100006104, 3.9311606884002686, 3.934161901473999]

ROC AUC for Isolation Forest applied on Shuttle

[0.9563387762318029, 0.9563387762318029, 0.9563387762318029, 0.9540169987848446, 0.9569192205935423]

/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.

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" be removed in 0.22.", DeprecationWarning)
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Execution time of IsolationForest applied on Shuttle (in second)

```
[3.933264970779419, 3.9803860187530518, 3.8767809867858887, 3.871199131011963, 3.90212082862854]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9574996649552819, 0.9540169987848446, 0.9563387762318029, 0.9563387762318029, 0.9569192205935423]
```

```
/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.
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```
FutureWarning)
```

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Execution time of IsolationForest applied on Shuttle (in second)

[4.150552034378052, 4.291000127792358, 3.911130905151367, 3.9013538360595703, 4.030745983123779]

ROC AUC for Isolation Forest applied on Shuttle

[0.9551778875083238, 0.9557583318700631, 0.9574996649552819, 0.9563387762318029, 0.9563387762318029]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[3.9282102584838867, 3.8578529357910156, 3.9022159576416016, 3.875404119491577, 3.8918538093566895]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9540169987848446, 0.9580801093170214, 0.9557583318700631, 0.9569192205935423, 0.9574996649552819]
```

```
/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.
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```

```
FutureWarning)
```

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Execution time of IsolationForest applied on Shuttle (in second)

[3.9072608947753906, 3.9310572147369385, 3.9529848098754883, 3.8775370121002197, 3.912390947341919]

ROC AUC for Isolation Forest applied on Shuttle

[0.9557583318700631, 0.9563387762318029, 0.9540169987848446, 0.9569192205935423, 0.9563387762318029]

/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.

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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[3.89054012298584, 3.930311918258667, 3.9629859924316406, 3.9004597663879395, 3.893911123275757]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9557583318700631, 0.9569192205935423, 0.9551778875083238, 0.9551778875083238, 0.9563387762318029]
```

```
/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.
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" be removed in 0.22.", DeprecationWarning)
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Execution time of IsolationForest applied on Shuttle (in second)

```
[4.295267105102539, 3.8758208751678467, 4.040041923522949, 4.03983211517334, 3.954232931137085]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9557583318700631, 0.954597443146584, 0.9534365544231049, 0.9563387762318029, 0.9569192205935423]
```

```
/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.
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```
FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```
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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[4.005141019821167, 3.9410972595214844, 3.95452976
22680664, 3.857922077178955, 3.967834234237671]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9551778875083238, 0.9557583318700631, 0.9557583
318700631, 0.9569192205935423, 0.9528561100613655]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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Execution time of IsolationForest applied on Shuttle (in second)

```
[3.9747982025146484, 4.207296133041382, 4.55889892578125, 4.271620035171509, 5.007630825042725]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9540169987848446, 0.954608411426319, 0.9528561100613655, 0.9551778875083238, 0.954597443146584]
```

```
/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.
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Execution time of IsolationForest applied on Shuttle (in second)  
[4.349613904953003, 4.237829208374023, 5.075235843658447, 5.2820611000061035, 4.61956000328064]  
ROC AUC for Isolation Forest applied on Shuttle  
[0.954597443146584, 0.9540169987848446, 0.9563497445115378, 0.9580801093170214, 0.9557583318700631]

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```
" be removed in 0.22.", DeprecationWarning)
```

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

```
[4.339015960693359, 4.297370910644531, 4.265887022
018433, 4.138870000839233, 4.207334280014038]
```

```
ROC AUC for Isolation Forest applied on Shuttle
```

```
[0.9574996649552819, 0.9557583318700631, 0.9557583
318700631, 0.9574996649552819, 0.9563387762318029]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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Execution time of IsolationForest applied on Shuttle (in second)

[4.161714315414429, 3.9941070079803467, 3.985264778137207, 4.2178308963775635, 4.153711795806885]

ROC AUC for Isolation Forest applied on Shuttle

[0.9569192205935423, 0.9563387762318029, 0.9563387762318029, 0.954597443146584, 0.9563387762318029]

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Execution time of IsolationForest applied on Shuttle (in second)

```
[4.098918914794922, 4.043912172317505, 4.263789653778076, 4.262359857559204, 4.068296909332275]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9551778875083238, 0.9551778875083238, 0.9563387762318029, 0.9569192205935423, 0.9563497445115378]
```

```
/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.
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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[4.010103225708008, 4.063582897186279, 4.415894031
524658, 4.241983890533447, 4.279377222061157]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9557583318700631, 0.9557583318700631, 0.9551778
875083238, 0.9528561100613655, 0.9534365544231049]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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" be removed in 0.22.", DeprecationWarning)
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Execution time of IsolationForest applied on Shuttle (in second)

```
[3.8847591876983643, 3.94231915473938, 3.959599018096924, 3.9523630142211914, 4.743088960647583]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9563387762318029, 0.9551778875083238, 0.9574996649552819, 0.9563387762318029, 0.9540169987848446]
```

```
/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.
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```
FutureWarning)
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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[4.01743483543396, 3.977637767791748, 3.965550184249878, 4.4193809032440186, 4.2286059856414795]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9569192205935423, 0.9563387762318029, 0.9563387762318029, 0.9540169987848446, 0.9557583318700631]
```

```
/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.
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```
" be removed in 0.22.", DeprecationWarning)
```

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

```
[3.970343828201294, 3.9281179904937744, 3.91411304
47387695, 3.9419898986816406, 3.8945741653442383]
```

```
ROC AUC for Isolation Forest applied on Shuttle
```

```
[0.954608411426319, 0.9563387762318029, 0.95633877
62318029, 0.9557583318700631, 0.958671521958496]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[4.005597829818726, 4.7027857303619385, 4.166394233703613, 4.0175559520721436, 3.946929931640625]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9557583318700631, 0.9551778875083238, 0.954597443146584, 0.9557583318700631, 0.9574996649552819]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in
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Execution time of IsolationForest applied on Shuttle (in second)

[4.384953260421753, 4.46699595451355, 4.482409954071045, 4.265742063522339, 4.14972710609436]

ROC AUC for Isolation Forest applied on Shuttle

[0.9563387762318029, 0.9569192205935423, 0.954608411426319, 0.9563387762318029, 0.9540169987848446]

/Users/thesard/anaconda3/lib/python3.7/site-packag

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Execution time of IsolationForest applied on Shuttle (in second)  
[4.193992853164673, 4.1953349113464355, 4.265631914138794, 4.3743791580200195, 4.402147054672241]  
ROC AUC for Isolation Forest applied on Shuttle  
[0.9557583318700631, 0.9551778875083238, 0.9540169987848446, 0.9563387762318029, 0.9557583318700631]

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Execution time of IsolationForest applied on Shuttle (in second)

[4.498809099197388, 4.512231349945068, 4.259091854095459, 4.3346641063690186, 4.7572081089019775]

ROC AUC for Isolation Forest applied on Shuttle

[0.9569192205935423, 0.9563387762318029, 0.9569192205935423, 0.9563387762318029, 0.9563387762318029]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[4.257203102111816, 4.3092100620269775, 4.219971179962158, 4.172997713088989, 4.1450018882751465]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9580801093170214, 0.9563387762318029, 0.9557583318700631, 0.9540169987848446, 0.9540169987848446]
```

```
/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)
```

```
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```
FutureWarning)
```

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```

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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[4.1707940101623535, 4.20831823348999, 4.187233924865723, 4.187788724899292, 4.23157000541687]

ROC AUC for Isolation Forest applied on Shuttle

[0.954597443146584, 0.9563387762318029, 0.954597443146584, 0.954597443146584, 0.9557583318700631]

/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.

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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[4.209234952926636, 4.21291184425354, 4.232439756393433, 4.301715850830078, 4.200225114822388]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9569192205935423, 0.9557583318700631, 0.9528561100613655, 0.9551778875083238, 0.9557583318700631]
```

```
/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.
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Execution time of IsolationForest applied on Shuttle (in second)

[4.246914863586426, 4.7061052322387695, 4.211495876312256, 4.2423670291900635, 4.214159965515137]

ROC AUC for Isolation Forest applied on Shuttle

[0.9563387762318029, 0.9551778875083238, 0.9563387762318029, 0.9551778875083238, 0.9534365544231049]

/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.

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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[4.160081148147583, 4.287575006484985, 4.156101226806641, 4.241755723953247, 4.248453855514526]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9551778875083238, 0.954597443146584, 0.9551778875083238, 0.9574996649552819, 0.9540169987848446]
```

```
/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.
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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[4.509351015090942, 4.232345104217529, 4.121835947036743, 4.17076301574707, 4.184201955795288]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9563387762318029, 0.9534365544231049, 0.9557583318700631, 0.954597443146584, 0.9563387762318029]
```

```
/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.
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```

```
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```
FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[4.394052028656006, 4.2077460289001465, 4.42009091
3772583, 4.603185176849365, 4.69140887260437]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.954597443146584, 0.9528561100613655, 0.95401699
87848446, 0.9540169987848446, 0.9551778875083238]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[4.5000159740448, 4.371948957443237, 4.465711832046509, 4.244058847427368, 4.318862676620483]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9563387762318029, 0.9563387762318029, 0.954597443146584, 0.9563387762318029, 0.954597443146584]
```

```
/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.
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Execution time of IsolationForest applied on Shuttle (in second)

[4.4683997631073, 4.335675001144409, 4.396737098693848, 4.542603969573975, 4.396227121353149]

ROC AUC for Isolation Forest applied on Shuttle

[0.9540169987848446, 0.9540169987848446, 0.9563497445115378, 0.9551778875083238, 0.9534365544231049]

/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.

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Execution time of IsolationForest applied on Shuttle (in second)

```
[4.404450178146362, 4.310791015625, 4.6654558181762695, 4.4045569896698, 4.397119998931885]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9557583318700631, 0.9557583318700631, 0.954597443146584, 0.9528561100613655, 0.9551778875083238]
```

```
/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.
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Execution time of IsolationForest applied on Shuttle (in second)

[4.581506013870239, 4.586035966873169, 4.8776397705078125, 4.565127849578857, 4.587188005447388]

ROC AUC for Isolation Forest applied on Shuttle

[0.954597443146584, 0.9563387762318029, 0.9540169987848446, 0.9528670783411003, 0.9563387762318029]

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Execution time of IsolationForest applied on Shuttle (in second)

```
[4.316172122955322, 4.570884943008423, 4.193691968917847, 4.191410779953003, 4.176440954208374]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9563387762318029, 0.9557583318700631, 0.9557583318700631, 0.9534365544231049, 0.9563497445115378]
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```
FutureWarning)
```



/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:417: DeprecationWarning: threshold\_ attribute is deprecated in 0.20 and will be removed in 0.22.

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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[4.184134006500244, 4.16471004486084, 4.3149869441
98608, 4.268862009048462, 4.456032037734985]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9534365544231049, 0.9563387762318029, 0.9534365
544231049, 0.954597443146584, 0.9551778875083238]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[4.300222873687744, 4.793097019195557, 4.933783054351807, 9.866403102874756, 7.239719867706299]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9557583318700631, 0.9557693001497983, 0.954597443146584, 0.9557583318700631, 0.9528561100613655]
```

```
/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.
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.521010875701904, 5.983904123306274, 5.7314839363098145, 5.93303918838501, 4.669845104217529]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9557583318700631, 0.9540169987848446, 0.9540169987848446, 0.9540169987848446, 0.9540169987848446]
```

```
/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.
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/Users/thesard/anaconda3/lib/python3.7/site-packag
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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[4.619654893875122, 4.879493951797485, 4.731890916
824341, 4.579391002655029, 4.327384948730469]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.954597443146584, 0.9551778875083238, 0.95343655
44231049, 0.9534365544231049, 0.9557583318700631]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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Execution time of IsolationForest applied on Shuttle (in second)
[4.321911096572876, 4.454334259033203, 5.214381217956543, 4.6630589962005615, 4.3286662101745605]
ROC AUC for Isolation Forest applied on Shuttle
[0.9534365544231049, 0.954597443146584, 0.9563387762318029, 0.9534365544231049, 0.954597443146584]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in
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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[4.2649500370025635, 4.301349878311157, 4.210487127304077, 4.288710832595825, 4.232382774353027]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.954597443146584, 0.9528670783411003, 0.9534365544231049, 0.9528561100613655, 0.9563387762318029]
```

```
/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 predict method behavior.

FutureWarning)

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    " be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)  
[4.383073091506958, 4.298237085342407, 4.2881920337677, 4.870344877243042, 4.250456094741821]  
ROC AUC for Isolation Forest applied on Shuttle  
[0.9551778875083238, 0.9528561100613655, 0.954597443146584, 0.9551778875083238, 0.9534365544231049]

/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.

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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[4.342082977294922, 4.425250768661499, 4.37638521194458, 4.579614162445068, 5.160731077194214]

ROC AUC for Isolation Forest applied on Shuttle

[0.9540169987848446, 0.9557583318700631, 0.9540169987848446, 0.9540169987848446, 0.9540169987848446]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[4.445434093475342, 4.278811931610107, 4.351726055145264, 4.293126821517944, 4.492408752441406]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9534365544231049, 0.9557583318700631, 0.9534365544231049, 0.9534584909825748, 0.9534365544231049]
```

```
/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)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/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.
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```
FutureWarning)
```

```
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```
FutureWarning)
```

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```

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Execution time of IsolationForest applied on Shuttle (in second)

[4.400272846221924, 4.738958835601807, 4.855146884918213, 5.060824155807495, 4.47209095954895]

ROC AUC for Isolation Forest applied on Shuttle

[0.9551778875083238, 0.9528561100613655, 0.9557583318700631, 0.9563387762318029, 0.9557583318700631]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[4.871447801589966, 4.449062347412109, 4.871093034744263, 4.4520487785339355, 4.394906044006348]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9551778875083238, 0.9557583318700631, 0.9534365544231049, 0.954597443146584, 0.9534365544231049]
```

```
/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.
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```
FutureWarning)
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```
FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:417: DeprecationWarning: threshold_ attribute is deprecated in 0.20 and will be removed in 0.22.
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```
/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)
/Users/thesard/anaconda3/lib/python3.7/site-packages/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)
```

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/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.

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Execution time of IsolationForest applied on Shuttle (in second)

[4.483388900756836, 4.725057125091553, 4.623542785644531, 4.430306911468506, 4.421915054321289]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528670783411003, 0.954608411426319, 0.954597443146584, 0.954597443146584, 0.9540169987848446]

/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.

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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[4.651585102081299, 4.458388090133667, 4.8230650424957275, 4.627558946609497, 4.957568883895874]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9551778875083238, 0.9563387762318029, 0.9534365544231049, 0.9540169987848446, 0.9540169987848446]
```

```
/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.
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[4.4996020793914795, 4.472329139709473, 4.414819955825806, 4.460031032562256, 4.45318078994751]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9540169987848446, 0.9540169987848446, 0.9540169987848446, 0.95344752270284, 0.9563387762318029]
```

```
/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.
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```

```
FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```
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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[4.68127179145813, 4.826618909835815, 4.5053391456
604, 4.637855052947998, 4.542662858963013]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9551778875083238, 0.9540169
987848446, 0.95344752270284, 0.954597443146584]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.366675853729248, 4.427242040634155, 4.725705862045288, 4.443206787109375, 4.9400389194488525]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.954597443146584, 0.954597443146584, 0.9528561100613655, 0.9557583318700631, 0.9528561100613655]
```

```
/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.
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Execution time of IsolationForest applied on Shuttle (in second)

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ROC AUC for Isolation Forest applied on Shuttle  
[0.9540169987848446, 0.9563497445115378, 0.954597443146584, 0.9557583318700631, 0.9557583318700631]

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```
" be removed in 0.22.", DeprecationWarning)
```

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

```
[5.042206048965454, 4.442486763000488, 5.071330785  
751343, 4.671712875366211, 4.4936442375183105]
```

```
ROC AUC for Isolation Forest applied on Shuttle
```

```
[0.9534365544231049, 0.9522756656996257, 0.9540169  
987848446, 0.9528561100613655, 0.9540169987848446]
```

```
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Execution time of IsolationForest applied on Shuttle (in second)

[4.45944619178772, 4.482097864151001, 5.707568168640137, 4.385945081710815, 4.866138935089111]

ROC AUC for Isolation Forest applied on Shuttle

[0.9557583318700631, 0.9540169987848446, 0.954597443146584, 0.9557583318700631, 0.9534365544231049]

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Execution time of IsolationForest applied on Shuttle (in second)

```
[4.373186826705933, 4.528943061828613, 4.47223973274231, 4.828330993652344, 5.1810808181762695]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9540169987848446, 0.9540169987848446, 0.9528561100613655, 0.9534365544231049]
```

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/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.
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```
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Execution time of IsolationForest applied on Shuttle (in second)

```
[4.500738143920898, 4.320502042770386, 4.491451978
683472, 4.359566688537598, 4.391304969787598]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9557583318700631, 0.9516952
213378863, 0.9551778875083238, 0.9534365544231049]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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Execution time of IsolationForest applied on Shuttle (in second)

```
[4.875292778015137, 4.409056901931763, 4.5158631801605225, 5.583805084228516, 4.724874973297119]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9551778875083238, 0.9540169987848446, 0.9557583318700631, 0.954597443146584, 0.9528561100613655]
```

```
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Execution time of IsolationForest applied on Shuttle (in second)

```
[4.731848239898682, 4.47626805305481, 4.250956058502197, 4.574193239212036, 4.68551778793335]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9563387762318029, 0.9528561100613655, 0.9528561100613655, 0.9534365544231049]
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```

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

```
[4.414568185806274, 4.363403081893921, 4.616960048
675537, 4.410731792449951, 4.541309118270874]
```

```
ROC AUC for Isolation Forest applied on Shuttle
```

```
[0.9528561100613655, 0.9551778875083238, 0.9534365
544231049, 0.9528561100613655, 0.9540169987848446]
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```
" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[4.487843990325928, 4.211528778076172, 4.183257102966309, 4.3061230182647705, 4.301344871520996]
ROC AUC for Isolation Forest applied on Shuttle
[0.9534365544231049, 0.9528561100613655, 0.9551778875083238, 0.9540169987848446, 0.9534365544231049]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in
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Execution time of IsolationForest applied on Shuttle (in second)

[4.777817964553833, 4.323198080062866, 4.297863960266113, 5.065001010894775, 4.497098922729492]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9528561100613655, 0.9540279670645795, 0.9528561100613655, 0.9534365544231049]

/Users/thesard/anaconda3/lib/python3.7/site-packag

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```

Execution time of IsolationForest applied on Shuttle (in second)  
[4.933732032775879, 5.051398754119873, 4.94162392616272, 4.818269968032837, 4.973757982254028]  
ROC AUC for Isolation Forest applied on Shuttle  
[0.954597443146584, 0.957510633235017, 0.9540169987848446, 0.9557583318700631, 0.9534365544231049]

/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.

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Execution time of IsolationForest applied on Shuttle (in second)

[5.145532846450806, 5.070394039154053, 5.052570104598999, 5.466110944747925, 5.16060209274292]

ROC AUC for Isolation Forest applied on Shuttle

[0.9551778875083238, 0.9534365544231049, 0.9528561100613655, 0.9534365544231049, 0.9557583318700631]

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" be removed in 0.22.", DeprecationWarning)
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Execution time of IsolationForest applied on Shuttle (in second)

```
[5.146963834762573, 5.292865037918091, 5.288604021072388, 5.366531133651733, 4.83336877822876]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.954597443146584, 0.9540169987848446, 0.9540169987848446, 0.9534365544231049, 0.9522756656996257]
```

```
/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.
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FutureWarning)
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FutureWarning)
```

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Execution time of IsolationForest applied on Shuttle (in second)

[5.271844148635864, 5.395264148712158, 4.991286993026733, 4.979462146759033, 5.290912866592407]

ROC AUC for Isolation Forest applied on Shuttle

[0.954597443146584, 0.9551778875083238, 0.9563607127912728, 0.9528561100613655, 0.954597443146584]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.452201843261719, 5.224328994750977, 5.421734809875488, 4.7350358963012695, 4.853984117507935]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9534365544231049, 0.9563387762318029, 0.9551778875083238, 0.9534365544231049, 0.9551778875083238]
```

```
/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.
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```
FutureWarning)
```



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Execution time of IsolationForest applied on Shuttle (in second)

[5.078830003738403, 5.648651123046875, 5.114403963088989, 5.52962589263916, 5.024048089981079]

ROC AUC for Isolation Forest applied on Shuttle

[0.954597443146584, 0.954597443146584, 0.9528561100613655, 0.954597443146584, 0.9551778875083238]

/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.

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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.132493019104004, 5.283343076705933, 5.174414873123169, 5.6536970138549805, 5.1744232177734375]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9534365544231049, 0.9534365544231049, 0.9534365544231049, 0.9557583318700631, 0.9528561100613655]
```

```
/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.
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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.029328107833862, 4.651957035064697, 5.592137813568115, 5.074856758117676, 5.496909856796265]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9534365544231049, 0.9540169987848446, 0.9522756656996257]
```

```
/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.
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```

```
FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
```

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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.145391941070557, 4.801406145095825, 4.899236917
4957275, 5.043386936187744, 6.464189052581787]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9557583318700631, 0.9528561
100613655, 0.9557583318700631, 0.9563387762318029]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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" be removed in 0.22.", DeprecationWarning)
```

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

```
[7.617064952850342, 6.469025135040283, 7.342291831
970215, 6.598548173904419, 5.7266950607299805]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9540169987848446, 0.9534365544231049, 0.9540169
987848446, 0.9528561100613655, 0.9528561100613655]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[5.623800754547119, 5.390009164810181, 6.157681941986084, 5.201539039611816, 5.489896059036255]

ROC AUC for Isolation Forest applied on Shuttle

[0.9551778875083238, 0.9534365544231049, 0.9540169987848446, 0.9540169987848446, 0.9528561100613655]

/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.

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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.490273952484131, 5.2475481033325195, 5.33028721  
8093872, 5.466248035430908, 6.003726959228516]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528670783411003, 0.9534365544231049, 0.9528561  
100613655, 0.9534365544231049, 0.9557583318700631]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag  
es/sklearn/ensemble/iforest.py:213: FutureWarning:  
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Execution time of IsolationForest applied on Shuttle (in second)

[6.287141799926758, 5.589874982833862, 5.352823972702026, 5.1558051109313965, 5.544419765472412]

ROC AUC for Isolation Forest applied on Shuttle

[0.9540169987848446, 0.9551778875083238, 0.9551778875083238, 0.9540169987848446, 0.9528561100613655]

/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.

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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.453874111175537, 6.349414825439453, 5.198186874389648, 5.353394031524658, 5.2974278926849365]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9551778875083238, 0.9551778875083238, 0.9528561100613655, 0.954597443146584]
```

```
/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.
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FutureWarning)
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FutureWarning)

/Users/thesard/anaconda3/lib/python3.7/site-packag

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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.32589316368103, 5.360241889953613, 6.3215050697
32666, 5.213317155838013, 5.288279056549072]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9551778875083238, 0.9540169987848446, 0.9551888
557880587, 0.9528561100613655, 0.9534365544231049]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.418087959289551, 7.693165063858032, 5.204850912094116, 5.433595180511475, 5.213503837585449]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9557583318700631, 0.9534365544231049, 0.9528561100613655, 0.9534365544231049, 0.9557583318700631]
```

```
/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.
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.8068389892578125, 7.241742134094238, 9.4741370677948, 8.354076147079468, 5.886538028717041]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9534365544231049, 0.9534365544231049, 0.9534365544231049, 0.954597443146584, 0.9528561100613655]
```

```
/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)
/Users/thesard/anaconda3/lib/python3.7/site-packag
```



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```
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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.134982109069824, 6.6827850341796875, 7.00399971
0083008, 6.326525926589966, 5.437199115753174]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9540169987848446, 0.9528670
783411003, 0.9540169987848446, 0.9528890149005704]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.312098026275635, 5.181644678115845, 5.200480937957764, 5.220791816711426, 5.32737922668457]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9534365544231049, 0.9534365544231049, 0.9557583318700631, 0.9522756656996257, 0.9540169987848446]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.4720258712768555, 5.25904393196106, 5.31505823135376, 5.1810431480407715, 5.236885070800781]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9534365544231049, 0.9557583318700631, 0.9534365544231049]
```

```
/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 predict method behavior.

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```



Execution time of IsolationForest applied on Shuttle (in second)  
[5.1820290088653564, 5.203927993774414, 5.339498043060303, 5.1660590171813965, 6.047141075134277]  
ROC AUC for Isolation Forest applied on Shuttle  
[0.9528561100613655, 0.9528561100613655, 0.954597443146584, 0.9540169987848446, 0.9551778875083238]

/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.

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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[6.320711135864258, 5.3318030834198, 5.099160194396973, 6.134141206741333, 5.105814218521118]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9534365544231049, 0.9551778875083238, 0.9540169987848446, 0.9540169987848446]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.045521259307861, 6.313049793243408, 5.443853855133057, 5.23342490196228, 5.2057130336761475]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.954597443146584, 0.9534365544231049, 0.9528561100613655, 0.9528670783411003]
```

```
/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)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/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.
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```
FutureWarning)
```

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```
FutureWarning)
```

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FutureWarning)
```

```
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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[5.194438219070435, 5.423864126205444, 5.308396816253662, 5.217756986618042, 5.544331789016724]

ROC AUC for Isolation Forest applied on Shuttle

[0.9540169987848446, 0.9528561100613655, 0.9534365544231049, 0.9528561100613655, 0.9540169987848446]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.242154121398926, 5.18276572227478, 5.204811096191406, 7.2726991176605225, 5.21291708946228]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9540169987848446, 0.9528561100613655, 0.9534365544231049]
```

```
/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.
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```
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/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:417: DeprecationWarning: threshold_ attribute is deprecated in 0.20 and will be removed in 0.22.
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/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.
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```

```
FutureWarning)
```

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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[5.4597508907318115, 5.324641227722168, 5.454147100448608, 5.580970048904419, 6.414352893829346]

ROC AUC for Isolation Forest applied on Shuttle

[0.9522756656996257, 0.9534365544231049, 0.9534365544231049, 0.9522756656996257, 0.9516952213378863]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.0011889934539795, 5.068345308303833, 5.196305990219116, 5.239849090576172, 5.239786863327026]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9557693001497983, 0.9528561100613655, 0.9528561100613655, 0.9534365544231049, 0.9534365544231049]
```

```
/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.
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.310281038284302, 7.75579309463501, 6.845024108886719, 7.442080020904541, 6.260913848876953]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9540169987848446, 0.954597443146584, 0.9528561100613655, 0.9540169987848446, 0.9551778875083238]
```

```
/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.
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```
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```
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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.5094521045684814, 5.211172103881836, 5.22194194
7937012, 5.2674338817596436, 5.3359129428863525]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9534365544231049, 0.9540169
987848446, 0.9534365544231049, 0.954597443146584]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.401376008987427, 5.214727878570557, 5.265749931335449, 6.002886056900024, 5.822770118713379]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9534365544231049, 0.9540169987848446, 0.954597443146584, 0.9528561100613655, 0.9534365544231049]
```

```
/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.
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Execution time of IsolationForest applied on Shuttle (in second)

[6.228795051574707, 5.835632085800171, 5.675727128982544, 5.606631755828857, 5.32342791557312]

ROC AUC for Isolation Forest applied on Shuttle  
[0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9540169987848446]

/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.

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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.235755920410156, 6.513939142227173, 6.219198942184448, 5.815216064453125, 5.685991048812866]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9534365544231049, 0.9534365544231049, 0.9522756656996257, 0.9528561100613655]
```

```
/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.
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```
FutureWarning)
```

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FutureWarning)
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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[5.590642929077148, 5.276201009750366, 7.319914817810059, 7.207799196243286, 6.346909999847412]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.678454637527466, 5.5605387687683105, 5.941073894500732, 5.8818910121917725, 5.810136079788208]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528670783411003, 0.9528670783411003, 0.9534365544231049, 0.9522756656996257]
```

```
/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.
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.104781150817871, 5.786194801330566, 5.784216880
79834, 6.387951135635376, 7.382651090621948]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9540169987848446, 0.9534365544231049, 0.9522756
656996257, 0.9528561100613655, 0.9534365544231049]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.55731201171875, 5.602009296417236, 5.629373788833618, 5.324066162109375, 5.577548027038574]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9534365544231049, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655]
```

```
/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.
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Execution time of IsolationForest applied on Shuttle (in second)

[8.234561920166016, 6.781275987625122, 5.6504621505737305, 5.724412202835083, 6.604156732559204]

ROC AUC for Isolation Forest applied on Shuttle

[0.9534365544231049, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655]

/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.

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```
" be removed in 0.22.", DeprecationWarning)
```

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

```
[7.186249017715454, 6.181585073471069, 5.529522180
557251, 6.7441229820251465, 5.917329788208008]
```

```
ROC AUC for Isolation Forest applied on Shuttle
```

```
[0.9534365544231049, 0.9534365544231049, 0.9528561
100613655, 0.9528561100613655, 0.9540169987848446]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```
FutureWarning)
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.729598045349121, 6.533745050430298, 6.720436096191406, 6.396567106246948, 5.4200968742370605]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9534365544231049, 0.9528561100613655, 0.9534365544231049, 0.9534365544231049, 0.9528561100613655]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.111553907394409, 6.024998903274536, 6.114391803741455, 7.542680025100708, 6.499190092086792]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9522866339793609, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655]
```

```
/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 predict method behavior.

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```

Execution time of IsolationForest applied on Shuttle (in second)  
[7.255598068237305, 5.503307104110718, 6.484577894210815, 8.812251806259155, 6.181572198867798]  
ROC AUC for Isolation Forest applied on Shuttle  
[0.9528561100613655, 0.9528561100613655, 0.9563387762318029, 0.9540279670645795, 0.9528561100613655]

/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.

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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[6.440357685089111, 6.9180872440338135, 6.2142109870910645, 5.93773889541626, 6.503332138061523]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528670783411003, 0.9540169987848446, 0.9528561100613655, 0.9528561100613655, 0.954597443146584]

/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.

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" be removed in 0.22.", DeprecationWarning)
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Execution time of IsolationForest applied on Shuttle (in second)

```
[8.040313005447388, 7.036953926086426, 6.230963945388794, 5.684778928756714, 7.290471076965332]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528780466208355, 0.9540169987848446, 0.9534365544231049, 0.9528561100613655]
```

```
/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.
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FutureWarning)
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```
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Execution time of IsolationForest applied on Shuttle (in second)

[8.635706663131714, 7.977365016937256, 6.539043188095093, 6.123455047607422, 5.524311065673828]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9557802684295332, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.8361310958862305, 5.284095287322998, 5.769735813140869, 6.9464850425720215, 6.871326923370361]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9534365544231049, 0.9534365544231049, 0.9534365544231049, 0.9534365544231049]
```

```
/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.
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```

```
FutureWarning)
```

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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[5.59429931640625, 5.574176073074341, 5.386014938354492, 5.2518110275268555, 5.285401821136475]

ROC AUC for Isolation Forest applied on Shuttle

[0.9540169987848446, 0.9540169987848446, 0.9528561100613655, 0.9528670783411003, 0.9528561100613655]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.699969053268433, 9.33476209640503, 9.499053239822388, 7.003056764602661, 5.381901025772095]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9540169987848446, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9528670783411003]
```

```
/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.
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.912731170654297, 5.310953140258789, 5.333834886550903, 5.230060815811157, 5.1894237995147705]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9534365544231049, 0.9528561100613655, 0.9528561100613655, 0.9534365544231049]
```

```
/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.
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```

```
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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.20169997215271, 5.316310882568359, 5.4124951362
60986, 5.238548994064331, 5.464491844177246]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9534365544231049, 0.954597443146584, 0.95285611
00613655, 0.9528561100613655, 0.954597443146584]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[8.201186180114746, 6.6310670375823975, 6.935633182525635, 8.537050247192383, 7.167674779891968]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9534365544231049, 0.95344752270284, 0.9522756656996257, 0.9528561100613655]
```

```
/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.
```

```
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```
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Execution time of IsolationForest applied on Shuttle (in second)  
[7.204329967498779, 8.717866897583008, 5.363418102264404, 5.49608302116394, 5.506414890289307]  
ROC AUC for Isolation Forest applied on Shuttle  
[0.9522756656996257, 0.9528561100613655, 0.9528561100613655, 0.954597443146584, 0.9534365544231049]

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```

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

```
[6.799155950546265, 8.122430086135864, 9.039242982
86438, 6.096894025802612, 5.700460910797119]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9540169987848446, 0.9528561100613655, 0.9516952
213378863, 0.9534365544231049, 0.9528561100613655]
```

```
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Execution time of IsolationForest applied on Shuttle (in second)

[7.577915906906128, 6.811534881591797, 6.307535886764526, 6.069572687149048, 5.888710975646973]

ROC AUC for Isolation Forest applied on Shuttle

[0.9540279670645795, 0.9528561100613655, 0.9528561100613655, 0.954597443146584, 0.9534365544231049]

/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.

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Execution time of IsolationForest applied on Shuttle (in second)

```
[7.907419919967651, 6.252690076828003, 6.119100332260132, 5.304948091506958, 5.776604890823364]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528670783411003, 0.9528561100613655, 0.9516952213378863, 0.9528561100613655]
```

```
/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.
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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.96930718421936, 6.416559934616089, 5.7487390041
35132, 7.832584857940674, 6.899614095687866]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9534365544231049, 0.9528561100613655, 0.9545974
43146584, 0.9534365544231049, 0.9540169987848446]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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Execution time of IsolationForest applied on Shuttle (in second)

```
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```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.954597443146584, 0.9528561100613655, 0.9534365544231049]
```

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/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.
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.1361589431762695, 6.453374862670898, 5.700024127960205, 5.1721320152282715, 5.244798898696899]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9534365544231049, 0.9528670783411003, 0.9522756656996257]
```

```
/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.
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FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.598062992095947, 5.176666736602783, 5.274925947
189331, 5.648171901702881, 6.4588422775268555]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.95344752270284, 0.953436554
4231049, 0.9540169987848446, 0.9534365544231049]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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Execution time of IsolationForest applied on Shutt
le (in second)
[5.851222991943359, 5.406338214874268, 5.270277976
989746, 5.571484804153442, 5.248628854751587]
ROC AUC for Isolation Forest applied on Shuttle
[0.9534365544231049, 0.9534365544231049, 0.9528561
100613655, 0.9528561100613655, 0.9534365544231049]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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Execution time of IsolationForest applied on Shuttle (in second)

```
[5.807517051696777, 5.391143798828125, 5.366087913513184, 5.37006688117981, 6.811671257019043]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9534365544231049, 0.9528561100613655, 0.9528561100613655, 0.9528890149005704, 0.9528561100613655]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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Execution time of IsolationForest applied on Shuttle (in second)

```
[6.0796799659729, 6.607493877410889, 5.459949016571045, 5.360926866531372, 5.317054986953735]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9540169987848446, 0.9528670783411003, 0.9528561100613655, 0.954597443146584, 0.9534365544231049]
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```
/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.
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Execution time of IsolationForest applied on Shuttle (in second)

[5.596600770950317, 5.875916004180908, 5.555190801620483, 5.438629865646362, 6.601583957672119]

ROC AUC for Isolation Forest applied on Shuttle

[0.9517171578973563, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9534365544231049]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.375389099121094, 6.449120044708252, 5.8435118198394775, 5.718081951141357, 6.2758729457855225]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9551778875083238, 0.9522866339793609, 0.954597443146584, 0.9528670783411003]
```

```
/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)
```

```
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FutureWarning)
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```
FutureWarning)
```

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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[6.785331964492798, 5.964800834655762, 6.395308017730713, 6.54468297958374, 6.960986137390137]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9528561100613655, 0.9528670783411003, 0.9522756656996257, 0.9528561100613655]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[10.70912790298462, 9.639806270599365, 7.736573934555054, 6.713379144668579, 6.322380065917969]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522866339793609, 0.9517171578973563, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655]
```

```
/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.
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```
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Execution time of IsolationForest applied on Shuttle (in second)

[6.6536171436309814, 5.990181922912598, 5.770965099334717, 5.643129110336304, 5.39064884185791]

ROC AUC for Isolation Forest applied on Shuttle

[0.954597443146584, 0.9528670783411003, 0.9528561100613655, 0.9540169987848446, 0.9528561100613655]

/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.

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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.341633081436157, 5.9325549602508545, 6.7479259967803955, 8.861902952194214, 6.450766086578369]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9528561100613655, 0.9551778875083238, 0.9522866339793609, 0.9522756656996257]
```

```
/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.
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.548531770706177, 5.616785049438477, 6.286784887313843, 6.111937999725342, 5.396918058395386]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9522756656996257, 0.9540169987848446, 0.9528561100613655]
```

```
/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.
```

```
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/Users/thesard/anaconda3/lib/python3.7/site-packag
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.458258152008057, 5.246147871017456, 5.639081239
700317, 6.126498222351074, 6.94778299331665]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9528561100613655, 0.9528561
100613655, 0.9528561100613655, 0.9516952213378863]
```

```
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Execution time of IsolationForest applied on Shuttle (in second)

```
[7.331603050231934, 5.355776071548462, 5.339010715484619, 6.671088695526123, 7.238595962524414]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9534365544231049, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655]
```

```
/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.
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" be removed in 0.22.", DeprecationWarning)  
  
Execution time of IsolationForest applied on Shuttle (in second)  
[7.388247013092041, 6.723710060119629, 5.945144176483154, 6.838213205337524, 6.287810802459717]  
ROC AUC for Isolation Forest applied on Shuttle  
[0.9522756656996257, 0.9528561100613655, 0.9528561100613655, 0.9528670783411003, 0.9534365544231049]

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```

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

```
[6.1091248989105225, 6.919551134109497, 6.54774188  
9953613, 5.33798885345459, 6.4636311531066895]
```

```
ROC AUC for Isolation Forest applied on Shuttle
```

```
[0.9528780466208355, 0.9534365544231049, 0.9528561  
100613655, 0.9522756656996257, 0.9534365544231049]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag  
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Execution time of IsolationForest applied on Shuttle (in second)

[6.491715908050537, 6.019090890884399, 5.3109681606292725, 5.345427989959717, 5.478755712509155]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9522866339793609, 0.954597443146584, 0.9516952213378863, 0.9528561100613655]

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[8.267614364624023, 6.029627084732056, 5.622429847717285, 5.754746913909912, 6.259536981582642]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9534365544231049, 0.9534365544231049, 0.9528561100613655]
```

```
/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.
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.423917055130005, 5.721116781234741, 5.661157846
450806, 5.383720874786377, 5.7201573848724365]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.954597443146584, 0.95286707
83411003, 0.9522756656996257, 0.9516952213378863]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.961413145065308, 6.599867105484009, 6.822127103805542, 6.484793186187744, 6.188004970550537]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9516952213378863, 0.9528561100613655, 0.9528561100613655]
```

```
/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.
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.908239841461182, 5.675609111785889, 6.076556921005249, 5.492865085601807, 5.560060977935791]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9540169987848446, 0.9528561100613655, 0.9534365544231049]
```

```
/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.
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```

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

```
[6.40094518661499, 6.815631151199341, 8.2153470516
20483, 9.54957890510559, 7.602544784545898]
```

```
ROC AUC for Isolation Forest applied on Shuttle
```

```
[0.9516952213378863, 0.9534365544231049, 0.9528561
100613655, 0.9534365544231049, 0.9528561100613655]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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Execution time of IsolationForest applied on Shuttle (in second)

```
[5.490327835083008, 5.325895309448242, 6.779510974884033, 6.032506942749023, 6.013633728027344]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528670783411003, 0.9528670783411003, 0.95344752270284, 0.9528561100613655, 0.9516952213378863]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.3670737743377686, 5.532531023025513, 6.632416725158691, 6.59995698928833, 5.436738729476929]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9534365544231049, 0.9528561100613655]
```

```
/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 predict method behavior.

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```

Execution time of IsolationForest applied on Shuttle (in second)  
[6.110142946243286, 5.474195957183838, 5.537309885025024, 5.5840020179748535, 5.516146898269653]  
ROC AUC for Isolation Forest applied on Shuttle  
[0.9534365544231049, 0.9516952213378863, 0.9534365544231049, 0.9511147769761468, 0.9528561100613655]

/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.

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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[5.4523210525512695, 5.467555999755859, 5.513567924499512, 5.475716829299927, 5.852828025817871]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528999831803054, 0.9516952213378863, 0.9528561100613655, 0.9534584909825748, 0.9528561100613655]

/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.

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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.564594984054565, 5.595480918884277, 5.600550889968872, 5.5614330768585205, 6.465839862823486]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9540169987848446, 0.954597443146584, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655]
```

```
/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)
```

```
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Execution time of IsolationForest applied on Shuttle (in second)

[5.416388034820557, 5.678903818130493, 5.45747184753418, 5.625556230545044, 5.512281179428101]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9534365544231049, 0.9534365544231049, 0.9528561100613655, 0.9540169987848446]

/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.

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" be removed in 0.22.", DeprecationWarning)
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Execution time of IsolationForest applied on Shuttle (in second)

```
[5.439044952392578, 5.46123194694519, 5.591017961502075, 5.5329930782318115, 5.632558107376099]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9528670783411003, 0.9528561100613655]
```

```
/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.
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FutureWarning)
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Execution time of IsolationForest applied on Shuttle (in second)

[6.758883714675903, 6.656680107116699, 6.55462121963501, 5.512578964233398, 5.68723726272583]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9528561100613655, 0.9522756656996257, 0.9528561100613655, 0.9528561100613655]

/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.

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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.551288843154907, 5.360140800476074, 5.546211004257202, 5.570479154586792, 6.15422511100769]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9534365544231049, 0.9540169987848446, 0.9516952213378863, 0.9528561100613655, 0.9528561100613655]
```

```
/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.
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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.692239999771118, 5.987697124481201, 5.551562786102295, 5.5369110107421875, 6.73264217376709]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9534365544231049]
```

```
/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.
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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.56593918800354, 5.775184869766235, 5.6438908576
96533, 5.609745740890503, 5.560206890106201]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.954597443146584, 0.9534365544231049, 0.95227566
56996257, 0.9528561100613655, 0.9528561100613655]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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Execution time of IsolationForest applied on Shuttle (in second)

```
[5.672668218612671, 5.531084060668945, 5.992675065994263, 5.466210126876831, 5.599891185760498]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9534365544231049, 0.9522756656996257, 0.9528670783411003, 0.9516952213378863, 0.9528670783411003]
```

```
/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.
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Execution time of IsolationForest applied on Shuttle (in second)

[5.490484237670898, 5.587944269180298, 5.524899959564209, 6.197221755981445, 5.549870729446411]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9557583318700631, 0.9528561100613655, 0.9528561100613655, 0.9540169987848446]

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.482163906097412, 5.838513135910034, 5.581434011  
459351, 5.510143041610718, 5.584107160568237]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9522756656996257, 0.9534475  
2270284, 0.9528561100613655, 0.9528561100613655]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag  
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Execution time of IsolationForest applied on Shuttle (in second)

[5.622580289840698, 5.427381992340088, 6.014669895172119, 6.96198296546936, 6.319924354553223]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9528561100613655, 0.9522756656996257, 0.9528561100613655, 0.9528561100613655]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.423306703567505, 6.239941120147705, 5.7229180335998535, 5.539380073547363, 5.476254940032959]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9522756656996257, 0.9528561100613655]
```

```
/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.
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/Users/thesard/anaconda3/lib/python3.7/site-packag

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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.5286900997161865, 5.539940118789673, 6.31457996
3684082, 6.640097141265869, 5.925493001937866]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9534365544231049, 0.9528670783411003, 0.9534365
544231049, 0.9528561100613655, 0.9522756656996257]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.431229114532471, 5.477115154266357, 5.662491321563721, 5.508334159851074, 6.250777244567871]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9516952213378863]
```

```
/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.
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.786970853805542, 5.683334112167358, 5.614957809448242, 5.588067054748535, 5.630805015563965]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9528561100613655, 0.9528561100613655, 0.9534365544231049, 0.9528561100613655]
```

```
/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)
/Users/thesard/anaconda3/lib/python3.7/site-packag
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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.86447286605835, 5.531832933425903, 5.5694031715
39307, 5.597275972366333, 5.645527124404907]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9528561100613655, 0.9528561
100613655, 0.9540169987848446, 0.9551778875083238]
```

```
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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.601616144180298, 5.443462133407593, 5.524708747
8637695, 6.243161201477051, 5.70456600189209]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9528780466208355, 0.9528561
100613655, 0.9528561100613655, 0.9528561100613655]
```

```
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.631448030471802, 5.620471000671387, 5.541176080703735, 5.688374042510986, 5.6091179847717285]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9528561100613655, 0.9534365544231049, 0.9528561100613655, 0.9528561100613655]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```

```
Execution time of IsolationForest applied on Shuttle (in second)
[5.8724682331085205, 6.427025318145752, 6.844703197479248, 6.109139919281006, 5.549890041351318]
ROC AUC for Isolation Forest applied on Shuttle
[0.9528561100613655, 0.9528670783411003, 0.9528561100613655, 0.9522756656996257, 0.9528561100613655]
```

```
/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.
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Execution time of IsolationForest applied on Shuttle (in second)

[5.653322219848633, 5.849004745483398, 6.012915134429932, 5.747523069381714, 5.566660165786743]

ROC AUC for Isolation Forest applied on Shuttle

[0.9516952213378863, 0.9528561100613655, 0.9522756656996257, 0.9528780466208355, 0.9528561100613655]

/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.

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Execution time of IsolationForest applied on Shuttle (in second)

```
[5.476500988006592, 6.462146043777466, 6.599728107452393, 5.689154148101807, 5.6145195960998535]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9522756656996257, 0.9522756656996257, 0.954597443146584, 0.9540169987848446]
```

```
/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)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/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.
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```
FutureWarning)
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FutureWarning)
```

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FutureWarning)
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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[6.180367946624756, 6.6856529712677, 7.217447996139526, 6.812577962875366, 5.766642808914185]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9522756656996257, 0.9528561100613655]

/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.

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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.591187953948975, 5.799352169036865, 5.62208104133606, 5.517955780029297, 5.692757844924927]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655]
```

```
/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.
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Execution time of IsolationForest applied on Shuttle (in second)

[5.678724765777588, 5.505496978759766, 5.4951348304748535, 5.522857904434204, 5.469962120056152]

ROC AUC for Isolation Forest applied on Shuttle

[0.9534365544231049, 0.9528561100613655, 0.9528561100613655, 0.9516952213378863, 0.9522756656996257]

/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.

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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.50611686706543, 5.482577800750732, 5.4780189990997314, 5.445752143859863, 5.493134021759033]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9534365544231049, 0.9528561100613655, 0.9528561100613655, 0.9522756656996257]
```

```
/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.
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" be removed in 0.22.", DeprecationWarning)
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Execution time of IsolationForest applied on Shuttle (in second)

```
[6.428492069244385, 5.4928038120269775, 5.367755889892578, 6.477524042129517, 5.455276012420654]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655]
```

```
/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.
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```
FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.430751085281372, 6.780672073364258, 6.713970184
326172, 5.893033981323242, 5.874637126922607]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9516952
213378863, 0.9528561100613655, 0.9528561100613655]
```

```
/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
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```

```
FutureWarning)
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```
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.348145961761475, 5.513108968734741, 8.643900871276855, 5.697550058364868, 5.508865118026733]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9528561100613655, 0.9528561100613655, 0.9528670783411003, 0.954597443146584]
```

```
/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.
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```
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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[6.753396987915039, 6.491140842437744, 6.589055299758911, 5.971995830535889, 5.4994847774505615]

ROC AUC for Isolation Forest applied on Shuttle  
[0.9528561100613655, 0.954597443146584, 0.9534365544231049, 0.9516952213378863, 0.9528561100613655]

/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.

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```
" be removed in 0.22.", DeprecationWarning)
```

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

```
[6.79516077041626, 5.60788893699646, 5.89808797836  
3037, 5.570929050445557, 11.568941116333008]
```

```
ROC AUC for Isolation Forest applied on Shuttle
```

```
[0.9528561100613655, 0.9528561100613655, 0.9528561  
100613655, 0.9528561100613655, 0.9540169987848446]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag  
es/sklearn/ensemble/iforest.py:213: FutureWarning:  
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```
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Execution time of IsolationForest applied on Shuttle (in second)

[10.777717113494873, 6.233602046966553, 7.720136880874634, 7.841248989105225, 6.042595148086548]

ROC AUC for Isolation Forest applied on Shuttle

[0.9522756656996257, 0.9534365544231049, 0.9528561100613655, 0.9528561100613655, 0.9522756656996257]

/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.

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Execution time of IsolationForest applied on Shuttle (in second)

```
[7.310281991958618, 7.379034996032715, 5.742488145828247, 5.825064182281494, 5.608044147491455]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9528670783411003, 0.9534365544231049]
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/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.
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FutureWarning)
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/Users/thesard/anaconda3/lib/python3.7/site-packag



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```
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/Users/thesard/anaconda3/lib/python3.7/site-packag
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.579780101776123, 6.307145833969116, 9.595422029
49524, 8.667910099029541, 7.2189459800720215]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9528561
100613655, 0.9528561100613655, 0.9528561100613655]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.732533931732178, 5.655640125274658, 6.319825172424316, 6.775820016860962, 6.135256052017212]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9528561100613655, 0.9534365544231049, 0.9522866339793609, 0.95344752270284]
```

```
/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.
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Execution time of IsolationForest applied on Shuttle (in second)

[6.931516885757446, 6.421972036361694, 6.865470886230469, 7.764721870422363, 8.162935018539429]

ROC AUC for Isolation Forest applied on Shuttle

[0.9534365544231049, 0.9528561100613655, 0.9540169987848446, 0.9528561100613655, 0.9528670783411003]

/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.

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```

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

```
[6.761070013046265, 6.38009786605835, 6.4741299152
37427, 6.57783317565918, 6.425743818283081]
```

```
ROC AUC for Isolation Forest applied on Shuttle
```

```
[0.9522756656996257, 0.9528561100613655, 0.9528561
100613655, 0.9528561100613655, 0.9516952213378863]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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" be removed in 0.22.", DeprecationWarning)
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Execution time of IsolationForest applied on Shuttle (in second)

```
[6.456283807754517, 5.883524656295776, 6.4706549644470215, 6.883293867111206, 7.5614588260650635]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9534365544231049, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655]
```

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/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in
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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.365033864974976, 5.924314975738525, 5.877778053283691, 6.621889114379883, 6.676654100418091]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```

Execution time of IsolationForest applied on Shuttle (in second)  
[7.019237041473389, 7.66464900970459, 6.6006920337677, 7.179158926010132, 7.323540925979614]  
ROC AUC for Isolation Forest applied on Shuttle  
[0.9528561100613655, 0.9528561100613655, 0.9522756656996257, 0.9528780466208355, 0.9528561100613655]

/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.

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Execution time of IsolationForest applied on Shuttle (in second)

[7.497772216796875, 6.582241773605347, 8.596102952957153, 6.712836742401123, 7.75665283203125]

ROC AUC for Isolation Forest applied on Shuttle

[0.9534804275420449, 0.954597443146584, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655]

/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.

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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.7683799266815186, 8.169856071472168, 6.520464897155762, 7.753397226333618, 6.664212942123413]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9534365544231049, 0.9522756656996257, 0.9516952213378863, 0.9528561100613655]
```

```
/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.
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FutureWarning)
```

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Execution time of IsolationForest applied on Shuttle (in second)

[6.387722969055176, 7.2630510330200195, 6.7515869140625, 7.894073009490967, 7.669710874557495]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9522756656996257, 0.9522756656996257]

/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.

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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.368306875228882, 7.021774768829346, 6.615750074386597, 6.669413089752197, 5.753857135772705]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9528561100613655, 0.9528561100613655, 0.9522756656996257, 0.9528561100613655]
```

```
/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.
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Execution time of IsolationForest applied on Shuttle (in second)

[6.949025869369507, 8.277520895004272, 8.574196100234985, 6.779942989349365, 6.857264757156372]

ROC AUC for Isolation Forest applied on Shuttle

[0.9522976022590958, 0.9528561100613655, 0.9522756656996257, 0.9528561100613655, 0.9528561100613655]

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.002523899078369, 7.049583196640015, 6.095746040344238, 5.495529890060425, 5.380614280700684]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9522756656996257, 0.9517171578973563, 0.9534365544231049, 0.9528561100613655]
```

```
/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.
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.6233179569244385, 6.207889795303345, 6.762802839279175, 6.111284971237183, 5.582478761672974]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9534365544231049, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9522756656996257]
```

```
/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.
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```
FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
```

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```

```
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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.139908075332642, 6.172041893005371, 5.637692928
314209, 5.799363136291504, 5.61783504486084]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528670783411003, 0.9516952213378863, 0.9522756
656996257, 0.9528999831803054, 0.9528561100613655]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.749515056610107, 5.6942620277404785, 5.703090190887451, 5.5547919273376465, 5.72473406791687]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528670783411003, 0.9528561100613655, 0.9516952213378863, 0.9534365544231049, 0.9528561100613655]
```

```
/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.
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Execution time of IsolationForest applied on Shuttle (in second)

[6.144358158111572, 5.644347190856934, 5.620781898498535, 5.579343318939209, 5.664071798324585]

ROC AUC for Isolation Forest applied on Shuttle  
[0.9516952213378863, 0.9528561100613655, 0.9528561100613655, 0.9528670783411003, 0.9534365544231049]

/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.

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```
" be removed in 0.22.", DeprecationWarning)
```

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

```
[5.578695297241211, 5.657921075820923, 5.555815935
134888, 5.511160135269165, 5.607242107391357]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9540169987848446, 0.9528561100613655, 0.9528561
100613655, 0.9528561100613655, 0.9522756656996257]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
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```
FutureWarning)
```

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```
FutureWarning)
```

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Execution time of IsolationForest applied on Shuttle (in second)

[7.0070929527282715, 5.680553913116455, 5.576539993286133, 6.023916006088257, 5.610152006149292]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9528561100613655, 0.9522756656996257, 0.9528780466208355, 0.9516952213378863]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.539707899093628, 5.53929877281189, 5.604587078094482, 5.971362113952637, 6.787315130233765]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9522756656996257, 0.9528561100613655, 0.9528670783411003, 0.9517061896176212]
```

```
/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.
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```
FutureWarning)
```



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/Users/thesard/anaconda3/lib/python3.7/site-packag

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.5766401290893555, 5.48740291595459, 5.463546991
348267, 6.543823957443237, 5.693541049957275]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9528670783411003, 0.9516952
213378863, 0.9522756656996257, 0.9528561100613655]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.472815990447998, 5.625210762023926, 5.764772176742554, 5.606279134750366, 6.499114036560059]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9540169987848446, 0.9522756656996257, 0.9528561100613655, 0.9528670783411003]
```

```
/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.
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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.722662925720215, 5.816506862640381, 5.559171199798584, 5.865671157836914, 6.556519031524658]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9528561100613655, 0.9516952213378863, 0.9522756656996257, 0.9522756656996257]
```

```
/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.
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```
FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.759780168533325, 6.601654052734375, 5.702847003
936768, 5.6495521068573, 5.557590961456299]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9517061896176212, 0.9528561
100613655, 0.9522756656996257, 0.9528561100613655]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.051586151123047, 6.0730979442596436, 6.404411792755127, 6.5086588859558105, 6.057168960571289]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522866339793609, 0.9540279670645795, 0.9528561100613655, 0.9522756656996257, 0.9516952213378863]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.117423057556152, 6.366907119750977, 5.596776008605957, 7.05107307434082, 6.32528829574585]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9528670783411003, 0.9516952213378863, 0.9528561100613655, 0.9528670783411003]
```

```
/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 predict method behavior.

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```

Execution time of IsolationForest applied on Shuttle (in second)  
[6.387819051742554, 6.256856203079224, 6.029712200164795, 6.168917179107666, 5.79189920425415]  
ROC AUC for Isolation Forest applied on Shuttle  
[0.9522756656996257, 0.9528780466208355, 0.9528780466208355, 0.9528561100613655, 0.9516952213378863]

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Execution time of IsolationForest applied on Shuttle (in second)

[6.057857036590576, 6.384023904800415, 6.403927803039551, 6.225048065185547, 6.473996162414551]

ROC AUC for Isolation Forest applied on Shuttle

[0.9516952213378863, 0.9528561100613655, 0.9534365544231049, 0.9528561100613655, 0.9516952213378863]

/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.

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Execution time of IsolationForest applied on Shuttle (in second)

```
[7.53880763053894, 6.108168840408325, 7.188776969909668, 8.763183116912842, 6.3103249073028564]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9528670783411003]
```

```
/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.
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```
FutureWarning)
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Execution time of IsolationForest applied on Shuttle (in second)

[6.270183801651001, 6.281943082809448, 6.072016000747681, 6.763237237930298, 5.855794906616211]

ROC AUC for Isolation Forest applied on Shuttle

[0.9522756656996257, 0.9522756656996257, 0.9534365544231049, 0.9516952213378863, 0.9528561100613655]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.605502128601074, 5.891304016113281, 7.308972120285034, 7.756494045257568, 7.153571844100952]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9534365544231049, 0.9522866339793609]
```

```
/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.
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```
FutureWarning)
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Execution time of IsolationForest applied on Shuttle (in second)

[6.687307834625244, 5.969470024108887, 5.977240085601807, 5.684116840362549, 6.438889980316162]

ROC AUC for Isolation Forest applied on Shuttle

[0.9522756656996257, 0.9528561100613655, 0.9528561100613655, 0.9516952213378863, 0.9522756656996257]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.026431322097778, 6.537388801574707, 9.183801174163818, 9.598236799240112, 9.056901216506958]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9540169987848446, 0.9528561100613655, 0.9516952213378863, 0.9528561100613655]
```

```
/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.
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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.310983896255493, 6.061801910400391, 7.799982070922852, 6.0475850105285645, 7.410860061645508]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9522756656996257, 0.9528561100613655, 0.9522756656996257, 0.9522756656996257]
```

```
/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.
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```

```
FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
```

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```
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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.100610017776489, 6.612548112869263, 6.517883300
78125, 5.8514790534973145, 8.151420831680298]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9528561
100613655, 0.9528670783411003, 0.9528561100613655]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.953535079956055, 7.476503133773804, 6.397109031677246, 5.937495946884155, 6.180737018585205]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9516952213378863, 0.9528561100613655, 0.9528561100613655, 0.9516952213378863]
```

```
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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[6.414898872375488, 8.189880847930908, 7.880189895629883, 6.967664003372192, 7.72006893157959]

ROC AUC for Isolation Forest applied on Shuttle  
[0.9528561100613655, 0.9522756656996257, 0.9534365544231049, 0.9511147769761468, 0.9522756656996257]

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```
" be removed in 0.22.", DeprecationWarning)
```

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

```
[6.968200922012329, 7.647696018218994, 7.203959941  
864014, 8.56734299659729, 7.01145601272583]
```

```
ROC AUC for Isolation Forest applied on Shuttle
```

```
[0.9528780466208355, 0.9528561100613655, 0.9522756  
656996257, 0.9528561100613655, 0.9528561100613655]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag  
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Execution time of IsolationForest applied on Shuttle (in second)

[6.120180130004883, 7.306027889251709, 6.486548900604248, 6.282217025756836, 5.91161322593689]

ROC AUC for Isolation Forest applied on Shuttle

[0.9516952213378863, 0.9516952213378863, 0.9528561100613655, 0.9522756656996257, 0.9516952213378863]

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Execution time of IsolationForest applied on Shuttle (in second)

```
[5.718783855438232, 6.6756391525268555, 7.12064003944397, 7.556287050247192, 10.708600997924805]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9516952213378863, 0.9528561100613655, 0.9540169987848446, 0.9528561100613655]
```

```
/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.
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Execution time of IsolationForest applied on Shuttle (in second)

```
[8.16042709350586, 6.32233190536499, 6.64603185653
6865, 6.070404052734375, 6.66455602645874]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528670783411003, 0.9528561100613655, 0.9528561
100613655, 0.9528561100613655, 0.9522756656996257]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.163135051727295, 6.416314125061035, 6.294156789779663, 7.457727909088135, 8.473658084869385]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528670783411003, 0.9528561100613655, 0.9528561100613655, 0.9522756656996257, 0.9528561100613655]
```

```
/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.
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```
FutureWarning)
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.830849647521973, 7.202533960342407, 6.316574811935425, 7.652667045593262, 6.6263978481292725]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9522756656996257, 0.9528561100613655, 0.9528561100613655, 0.9516952213378863]
```

```
/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)
/Users/thesard/anaconda3/lib/python3.7/site-packag
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" be removed in 0.22.", DeprecationWarning)
```

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

```
[6.1239259243011475, 8.325933933258057, 9.40932297
706604, 8.00302004814148, 8.961788892745972]
```

```
ROC AUC for Isolation Forest applied on Shuttle
```

```
[0.9522756656996257, 0.9522756656996257, 0.9517061
896176212, 0.9528670783411003, 0.9511147769761468]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```
" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[7.403364181518555, 7.246460914611816, 6.705325126647949, 6.02711296081543, 6.0723841190338135]
ROC AUC for Isolation Forest applied on Shuttle
[0.9528561100613655, 0.9534365544231049, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in
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Execution time of IsolationForest applied on Shuttle (in second)

[5.588137865066528, 5.55594801902771, 5.683969736099243, 5.601377964019775, 5.4902567863464355]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9528670783411003, 0.9522756656996257]

/Users/thesard/anaconda3/lib/python3.7/site-packag

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Execution time of IsolationForest applied on Shuttle (in second)  
[6.506898880004883, 5.729676723480225, 7.316934823989868, 6.106765031814575, 7.922196865081787]  
ROC AUC for Isolation Forest applied on Shuttle  
[0.9528561100613655, 0.9516952213378863, 0.9528670783411003, 0.9528561100613655, 0.9511147769761468]

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ning: threshold\_ attribute is deprecated in 0.20 and will be removed in 0.22.

" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[7.377751111984253, 5.283155918121338, 5.6440041065216064, 5.484262943267822, 5.528841972351074]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9522756656996257, 0.9528561100613655, 0.9522756656996257, 0.9528561100613655]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.4420459270477295, 5.463665723800659, 5.473175048828125, 6.834255218505859, 7.4409730434417725]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9528561100613655, 0.9534365544231049, 0.9528561100613655, 0.9522756656996257]
```

```
/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)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/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.
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```
FutureWarning)
```

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```
FutureWarning)
```

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FutureWarning)
```

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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[7.958012819290161, 7.1718528270721436, 6.211922883987427, 7.623747110366821, 6.417176008224487]

ROC AUC for Isolation Forest applied on Shuttle

[0.9517061896176212, 0.9528561100613655, 0.9516952213378863, 0.9528561100613655, 0.9522756656996257]

/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.

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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.043136119842529, 5.863086938858032, 6.3073999881744385, 6.200184106826782, 5.618789911270142]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9534365544231049, 0.9522866339793609, 0.9528561100613655, 0.9522756656996257]
```

```
/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)
/Users/thesard/anaconda3/lib/python3.7/site-packages/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.
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```
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```
FutureWarning)
```



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Execution time of IsolationForest applied on Shuttle (in second)

[6.449519157409668, 7.997944116592407, 6.460751056671143, 6.0320539474487305, 8.377536058425903]

ROC AUC for Isolation Forest applied on Shuttle

[0.9522756656996257, 0.9522756656996257, 0.9528561100613655, 0.9516952213378863, 0.9517061896176212]

/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.

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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.108914852142334, 5.606444597244263, 6.57375693321228, 5.951447248458862, 5.519001245498657]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9528561100613655, 0.9528561100613655, 0.9522756656996257, 0.9516952213378863]
```

```
/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.
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```
FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packages/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-packages/sklearn/ensemble/iforest.py:417: DeprecationWarning: threshold_ attribute is deprecated in 0.20 and will be removed in 0.22.
```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.649537086486816, 5.721905946731567, 5.355789661407471, 5.434367895126343, 5.513435125350952]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9528561100613655, 0.9528561100613655, 0.9522756656996257, 0.9522756656996257]
```

```
/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.
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```
FutureWarning)
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```

```
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.

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/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.483418703079224, 5.566595792770386, 6.684499979
019165, 5.832510948181152, 6.151125907897949]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9516952
213378863, 0.9528561100613655, 0.9516952213378863]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[9.019262075424194, 7.390687942504883, 6.855198860168457, 5.88020396232605, 6.473696947097778]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528670783411003, 0.9522756656996257, 0.9528561100613655, 0.9528561100613655]
```

```
/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.
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```
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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[6.793335914611816, 7.362812042236328, 6.804327964782715, 7.299462080001831, 6.600948095321655]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9522756656996257, 0.9528561100613655, 0.9522756656996257, 0.9516952213378863]

/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.

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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.825990915298462, 7.043607234954834, 7.263339042  
663574, 6.762954950332642, 6.451088905334473]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9528561  
100613655, 0.954597443146584, 0.9516952213378863]
```

```
/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  
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```
FutureWarning)
```

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```
FutureWarning)
```

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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[6.988126039505005, 7.529237985610962, 8.396245002746582, 8.211745023727417, 6.667330980300903]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9528561100613655, 0.9528670783411003, 0.9517061896176212, 0.9528561100613655]

/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.

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```
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```
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```
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```
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.2202229499816895, 6.202320098876953, 6.8157312870025635, 7.102480888366699, 7.356805801391602]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9517171578973563, 0.9522756656996257, 0.9528561100613655, 0.9528670783411003]
```

```
/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.
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/Users/thesard/anaconda3/lib/python3.7/site-packag

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.329525947570801, 6.6371378898620605, 6.11834120
75042725, 6.556909084320068, 6.077858209609985]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9511147769761468, 0.9517061896176212, 0.9511147
769761468, 0.9528561100613655, 0.9516952213378863]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.266686916351318, 6.217122793197632, 6.194723129272461, 6.018767833709717, 6.166080951690674]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9522756656996257, 0.9528561100613655, 0.9516952213378863, 0.9528561100613655]
```

```
/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.
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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[5.862369060516357, 6.218884229660034, 6.002936840057373, 6.191878318786621, 5.661587953567505]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9534365544231049, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655]

/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.

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/Users/thesard/anaconda3/lib/python3.7/site-packag



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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.776879787445068, 6.153218030929565, 6.777298212
051392, 6.682610988616943, 5.891060829162598]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9516952
213378863, 0.9522756656996257, 0.9528561100613655]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```

```
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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.038080930709839, 7.179886817932129, 7.051678180
69458, 7.87305474281311, 6.508711099624634]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9522756656996257, 0.9528561
100613655, 0.9528561100613655, 0.9516952213378863]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[14.785643100738525, 7.649082899093628, 15.07984209060669, 9.183138847351074, 8.699157953262329]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9522756656996257, 0.9528561100613655, 0.9522756656996257]
```

```
/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 predict method behavior.

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    " be removed in 0.22.", DeprecationWarning)
```



Execution time of IsolationForest applied on Shuttle (in second)  
[6.855926990509033, 6.45186710357666, 8.576176166534424, 6.052778720855713, 5.803992986679077]  
ROC AUC for Isolation Forest applied on Shuttle  
[0.9522756656996257, 0.9528561100613655, 0.9522756656996257, 0.9516952213378863, 0.9528561100613655]

/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.

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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[5.635345220565796, 5.815522909164429, 6.642351865768433, 6.052004098892212, 6.606693267822266]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655]

/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.

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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.59788966178894, 6.61579704284668, 5.861419200897217, 5.644150972366333, 5.933683156967163]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9516952213378863, 0.9528561100613655, 0.9522756656996257, 0.9528561100613655]
```

```
/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.
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```
FutureWarning)
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```
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```
FutureWarning)
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```
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FutureWarning)
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Execution time of IsolationForest applied on Shuttle (in second)

[5.598714113235474, 6.496949672698975, 6.649860858917236, 5.984087228775024, 5.896461009979248]

ROC AUC for Isolation Forest applied on Shuttle

[0.9516952213378863, 0.9528561100613655, 0.9528561100613655, 0.9534365544231049, 0.9516952213378863]

/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.

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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.869029998779297, 6.071105003356934, 6.757043123245239, 6.358831167221069, 6.761993885040283]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9516952213378863, 0.9522756656996257, 0.9522756656996257, 0.9522756656996257]
```

```
/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.
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FutureWarning)
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```

```
FutureWarning)
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```
FutureWarning)
```

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Execution time of IsolationForest applied on Shuttle (in second)

[6.324761152267456, 5.868016242980957, 6.900125980377197, 6.290455102920532, 6.529371738433838]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9522756656996257, 0.9516952213378863, 0.9511147769761468, 0.9528561100613655]

/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.

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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.063315153121948, 6.464087009429932, 6.031085729598999, 7.100090026855469, 5.9134368896484375]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9522756656996257, 0.9528670783411003, 0.9528561100613655, 0.9516952213378863]
```

```
/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.
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.162155866622925, 5.693681716918945, 5.646586894989014, 5.643686056137085, 6.949889183044434]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9528561100613655, 0.9516952213378863, 0.9522756656996257, 0.9516952213378863]
```

```
/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.
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```
FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```
" be removed in 0.22.", DeprecationWarning)
```

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

```
[6.405365943908691, 5.855646848678589, 5.602918863
296509, 5.707466125488281, 5.631253957748413]
```

```
ROC AUC for Isolation Forest applied on Shuttle
```

```
[0.9516952213378863, 0.9528561100613655, 0.9522756
656996257, 0.9528780466208355, 0.9511367135356167]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.523762941360474, 7.367027997970581, 6.462417840957642, 5.763578176498413, 5.435356855392456]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9511257452558817, 0.9528561100613655, 0.9522756656996257, 0.9516952213378863]
```

```
/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.
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Execution time of IsolationForest applied on Shuttle (in second)

[5.4745142459869385, 5.56551194190979, 5.524867057800293, 5.228678941726685, 6.6114280223846436]

ROC AUC for Isolation Forest applied on Shuttle  
[0.9516952213378863, 0.9528561100613655, 0.9516952213378863, 0.9528561100613655, 0.9522756656996257]

/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.

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```
" be removed in 0.22.", DeprecationWarning)
```

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

```
[6.762827157974243, 7.063235759735107, 7.820738077
163696, 11.05912709236145, 10.893711805343628]
```

```
ROC AUC for Isolation Forest applied on Shuttle
```

```
[0.9528561100613655, 0.9522976022590958, 0.9528561
100613655, 0.9522756656996257, 0.9528561100613655]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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Execution time of IsolationForest applied on Shuttle (in second)

[7.3801469802856445, 7.501659154891968, 6.3724610805511475, 5.733818292617798, 6.634516000747681]

ROC AUC for Isolation Forest applied on Shuttle

[0.9516952213378863, 0.9522756656996257, 0.9516952213378863, 0.9522756656996257, 0.9516952213378863]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.510760068893433, 6.530346870422363, 6.563983201980591, 6.645966053009033, 8.417801856994629]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9522756656996257, 0.9522756656996257, 0.9522866339793609]
```

```
/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.
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/Users/thesard/anaconda3/lib/python3.7/site-packag

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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.3093791007995605, 5.800523996353149, 5.53446602
8213501, 6.263302326202393, 7.157499074935913]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9528561100613655, 0.9528670
783411003, 0.9528670783411003, 0.9528561100613655]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.233236789703369, 6.879087686538696, 5.822566747665405, 7.581134080886841, 5.727856159210205]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9516952213378863, 0.9528561100613655, 0.9528561100613655]
```

```
/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.
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.888918161392212, 6.997146129608154, 6.6012959480285645, 6.063472032546997, 7.148007869720459]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9522756656996257, 0.9528561100613655]
```

```
/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)
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```

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

```
[7.188612937927246, 6.633973121643066, 7.134237051
010132, 6.917219161987305, 7.236025810241699]
```

```
ROC AUC for Isolation Forest applied on Shuttle
```

```
[0.9522756656996257, 0.9522756656996257, 0.9528561
100613655, 0.9516952213378863, 0.9516952213378863]
```

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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.401601076126099, 6.566226959228516, 7.153873920440674, 6.749555349349976, 6.468202114105225]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9522866339793609, 0.9528561100613655, 0.9516952213378863, 0.9516952213378863]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in
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Execution time of IsolationForest applied on Shuttle (in second)

[6.664724111557007, 7.709325075149536, 7.499509811401367, 6.799408912658691, 6.6225080490112305]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9516952213378863, 0.9522756656996257, 0.9528561100613655, 0.9511147769761468]

/Users/thesard/anaconda3/lib/python3.7/site-packag

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```

Execution time of IsolationForest applied on Shuttle (in second)  
[8.678709983825684, 9.086862087249756, 9.088441133499146, 8.719450950622559, 7.674060821533203]  
ROC AUC for Isolation Forest applied on Shuttle  
[0.9534365544231049, 0.9528561100613655, 0.9528561100613655, 0.9522756656996257, 0.9522866339793609]

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Execution time of IsolationForest applied on Shuttle (in second)

[7.3794167041778564, 6.0271501541137695, 6.003840923309326, 6.535233020782471, 6.45203709602356]

ROC AUC for Isolation Forest applied on Shuttle

[0.9522756656996257, 0.9522756656996257, 0.9528561100613655, 0.9522756656996257, 0.9528561100613655]

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" be removed in 0.22.", DeprecationWarning)
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Execution time of IsolationForest applied on Shuttle (in second)

```
[5.718578815460205, 6.0933451652526855, 6.258286237716675, 6.816864967346191, 7.517214059829712]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9516952213378863, 0.9522756656996257, 0.9511367135356167, 0.9522756656996257]
```

```
/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)
```

```
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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[6.0990869998931885, 6.611634969711304, 6.715313911437988, 7.100453853607178, 6.835058927536011]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9516952213378863, 0.9528561100613655, 0.9528561100613655, 0.9522756656996257]

/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.

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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.848363161087036, 6.8148369789123535, 6.369797945022583, 6.84264612197876, 7.05255126953125]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528670783411003, 0.9528561100613655, 0.9522756656996257, 0.9528561100613655, 0.9516952213378863]
```

```
/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.
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Execution time of IsolationForest applied on Shuttle (in second)

[7.71966290473938, 7.45440673828125, 6.50977087020874, 6.888083219528198, 6.384497165679932]

ROC AUC for Isolation Forest applied on Shuttle

[0.9517061896176212, 0.9528561100613655, 0.9516952213378863, 0.9516952213378863, 0.9522756656996257]

/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.

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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.418905735015869, 6.1822898387908936, 6.941504955291748, 6.362799882888794, 7.096648931503296]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9516952213378863, 0.9528561100613655, 0.9528780466208355, 0.9516952213378863]
```

```
/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.
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Execution time of IsolationForest applied on Shuttle (in second)

```
[6.089420795440674, 6.064555883407593, 9.025016069412231, 6.5019659996032715, 7.480015277862549]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9522866339793609, 0.9523085705388309, 0.9516952213378863, 0.9516952213378863]
```

```
/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.
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```

```
FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
```



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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[8.832831144332886, 6.558608770370483, 8.309790849
685669, 5.985491991043091, 5.462111949920654]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9505343326144072, 0.9522756656996257, 0.9528670
783411003, 0.9528561100613655, 0.9522756656996257]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.5426390171051025, 6.246912002563477, 7.297106027603149, 7.248059272766113, 6.3699281215667725]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9516952213378863, 0.9522756656996257, 0.9522756656996257, 0.9528561100613655]
```

```
/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.
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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[5.204367160797119, 5.190184831619263, 5.950654983520508, 5.370268106460571, 5.35807204246521]

ROC AUC for Isolation Forest applied on Shuttle  
[0.9511147769761468, 0.9528670783411003, 0.9528561100613655, 0.9522756656996257, 0.9522756656996257]

/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.

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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.268919944763184, 5.308265924453735, 5.337754011154175, 6.023271799087524, 6.295899868011475]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9516952213378863, 0.9522756656996257, 0.9528561100613655, 0.9528561100613655]
```

```
/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.
```

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Execution time of IsolationForest applied on Shuttle (in second)

[5.461741924285889, 5.256748676300049, 5.333762168884277, 5.172693967819214, 5.724379777908325]

ROC AUC for Isolation Forest applied on Shuttle

[0.9511147769761468, 0.9522756656996257, 0.9528561100613655, 0.9516952213378863, 0.9528561100613655]

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Execution time of IsolationForest applied on Shuttle (in second)

```
[5.548904895782471, 5.3985960483551025, 5.537513971328735, 5.324256181716919, 5.361000061035156]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9528561100613655, 0.9522756656996257, 0.9511147769761468, 0.9516952213378863]
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/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.
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nd will be removed in 0.22.
```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.9569337368011475, 790.2170412540436, 5.94060611
7248535, 6.852154016494751, 11.669615030288696]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9522756656996257, 0.9516952
213378863, 0.9528561100613655, 0.9516952213378863]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
default contamination parameter 0.1 will change in
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```

```
FutureWarning)
```

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[9.76380205154419, 8.716449975967407, 2261.7124559879303, 5.998076915740967, 8.191114902496338]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9516952213378863, 0.9522756656996257, 0.9516952213378863, 0.9516952213378863]
```

```
/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.
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[9.053572177886963, 8.700493097305298, 8.226647138595581, 9.099997997283936, 8.873100996017456]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9516952213378863, 0.9534365544231049, 0.9522756656996257, 0.9522756656996257]
```

```
/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.
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```
FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[8.456501007080078, 8.215855121612549, 8.397037744
522095, 8.312743902206421, 7.597280025482178]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9534365544231049, 0.9516952213378863, 0.9528670
783411003, 0.9517061896176212, 0.9517061896176212]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
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```
" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[8.28347396850586, 7.170591831207275, 7.1592011451
72119, 7.297343015670776, 7.793338060379028]
ROC AUC for Isolation Forest applied on Shuttle
[0.9516952213378863, 0.9528561100613655, 0.9528890
149005704, 0.9528561100613655, 0.9522866339793609]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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Execution time of IsolationForest applied on Shuttle (in second)

```
[8.087783098220825, 7.308747053146362, 6.98111891746521, 7.322896957397461, 7.80035400390625]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9523195388185657, 0.9528561100613655]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:417: DeprecationWar
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nd will be removed in 0.22.
    " be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)  
[8.64197301864624, 7.46285080909729, 7.732068777084351, 7.141580104827881, 6.869160175323486]  
ROC AUC for Isolation Forest applied on Shuttle  
[0.9516952213378863, 0.9516952213378863, 0.9516952213378863, 0.9516952213378863, 0.9528561100613655]

/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.

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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[7.868856191635132, 8.235435009002686, 7.372114896774292, 7.005303144454956, 7.461381912231445]

ROC AUC for Isolation Forest applied on Shuttle

[0.9517061896176212, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9522756656996257]

/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.

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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.876100778579712, 6.883315324783325, 6.9593658447265625, 7.376741886138916, 7.157212972640991]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9522756656996257, 0.9528561100613655, 0.9511147769761468, 0.9511257452558817]
```

```
/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)
```

```
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```
FutureWarning)
```

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```
FutureWarning)
```

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FutureWarning)
```

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Execution time of IsolationForest applied on Shuttle (in second)

[7.634745836257935, 7.635683059692383, 8.133742094039917, 7.149983882904053, 7.41161322593689]

ROC AUC for Isolation Forest applied on Shuttle

[0.9522756656996257, 0.9516952213378863, 0.9528561100613655, 0.9522756656996257, 0.9516952213378863]

/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.

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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.474353075027466, 7.552749156951904, 7.207758903503418, 7.1093430519104, 6.941457033157349]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9528561100613655, 0.951695213378863, 0.9516952213378863, 0.9522756656996257]
```

```
/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.
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FutureWarning)
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Execution time of IsolationForest applied on Shuttle (in second)

[6.884843111038208, 7.1263816356658936, 6.922940254211426, 6.788668870925903, 7.071467876434326]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9516952213378863, 0.9522756656996257, 0.9522756656996257, 0.9528561100613655]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.860980987548828, 6.9112279415130615, 6.888972997665405, 7.637573957443237, 7.61799693107605]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9522756656996257, 0.9522756656996257, 0.9516952213378863, 0.9528670783411003]
```

```
/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.
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.2567760944366455, 7.276057958602905, 7.046231031417847, 6.987537860870361, 7.289031982421875]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528670783411003, 0.9516952213378863, 0.9516952213378863, 0.9528561100613655]
```

```
/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.
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```

```
FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
```

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```

```
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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[8.025180101394653, 8.314291954040527, 7.935974836
349487, 7.214355945587158, 7.412148952484131]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9516952213378863, 0.9517061
896176212, 0.9516952213378863, 0.9528561100613655]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[8.655956983566284, 13.887287139892578, 33.361958265304565, 35.40488600730896, 35.04923224449158]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9528561100613655, 0.9516952213378863, 0.9516952213378863, 0.9516952213378863]
```

```
/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.
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```
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```
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Execution time of IsolationForest applied on Shuttle (in second)

[35.670291900634766, 49.46217489242554, 46.2153379171448, 35.71410012245178, 19.06368088722229]

ROC AUC for Isolation Forest applied on Shuttle  
[0.9516952213378863, 0.9511147769761468, 0.9528561100613655, 0.9522756656996257, 0.9517061896176212]

/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.

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FutureWarning)
```

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FutureWarning)
```

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[12.969436883926392, 12.173794984817505, 11.465103149414062, 11.631957054138184, 11.91239309310913]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9516952213378863, 0.9522756656996257, 0.9522756656996257, 0.9517061896176212]
```

```
/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)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/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)
```

```
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Execution time of IsolationForest applied on Shuttle (in second)

[12.640431880950928, 17.45982599258423, 29.221701860427856, 32.57859492301941, 36.64477801322937]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528670783411003, 0.9528561100613655, 0.9522756656996257, 0.9511147769761468, 0.9528561100613655]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[28.494778871536255, 14.19143295288086, 12.510462045669556, 11.033584117889404, 10.479866743087769]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9528561100613655, 0.9522756656996257, 0.9511257452558817, 0.9522756656996257]
```

```
/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.
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[10.399050951004028, 10.697959899902344, 11.973716
259002686, 15.47554874420166, 22.451143980026245]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9516952213378863, 0.9522756
656996257, 0.9528561100613655, 0.9516952213378863]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[25.66904091835022, 29.315642833709717, 30.70438289642334, 32.589601039886475, 25.759345054626465]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9516952213378863, 0.9528561100613655, 0.9516952213378863, 0.9522756656996257]
```

```
/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.
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[14.397625923156738, 14.297590017318726, 13.000563859939575, 14.101053953170776, 14.590770244598389]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9516952213378863, 0.9528561100613655, 0.9516952213378863, 0.9516952213378863]
```

```
/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.
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```
FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```

```
" be removed in 0.22.", DeprecationWarning)
```

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

```
[26.00067400932312, 30.750399112701416, 20.4149138
9274597, 17.925140142440796, 16.549232959747314]
```

```
ROC AUC for Isolation Forest applied on Shuttle
```

```
[0.9516952213378863, 0.9516952213378863, 0.9511147
769761468, 0.9522756656996257, 0.9516952213378863]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[20.728245973587036, 16.65848684310913, 15.423629760742188, 14.191252946853638, 18.80627703666687]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9528561100613655, 0.9511147769761468, 0.9517061896176212, 0.9522756656996257]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in
```

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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[18.828509092330933, 26.69545316696167, 26.101886987686157, 21.724517107009888, 16.537705898284912]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522866339793609, 0.9522756656996257, 0.9522756656996257, 0.9528561100613655, 0.9516952213378863]
```

```
/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 predict method behavior.

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```

Execution time of IsolationForest applied on Shuttle (in second)  
[20.63426399230957, 22.503912210464478, 20.224736213684082, 22.961063861846924, 21.42127513885498]  
ROC AUC for Isolation Forest applied on Shuttle  
[0.9522756656996257, 0.9522756656996257, 0.9516952213378863, 0.9516952213378863, 0.9516952213378863]

/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.

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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[875.0556619167328, 6.54228401184082, 8.82716989517212, 12.577082872390747, 9.518525123596191]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9516952213378863, 0.9517061896176212, 0.9516952213378863, 0.9528561100613655]

/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.

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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[9.105414867401123, 2162.441416978836, 7.172648906
707764, 7.988067150115967, 8.284706115722656]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9516952
213378863, 0.9528561100613655, 0.9522866339793609]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
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FutureWarning)
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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[7.227166175842285, 7.518197059631348, 7.275151014328003, 6.886754989624023, 7.006214141845703]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9528561100613655, 0.9516952213378863, 0.9522756656996257, 0.9516952213378863]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.186699151992798, 7.632532835006714, 7.205880880355835, 6.841742753982544, 7.236272096633911]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9516952213378863, 0.9511147769761468, 0.9522756656996257, 0.9516952213378863]
```

```
/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.
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Execution time of IsolationForest applied on Shuttle (in second)

[6.809206962585449, 7.16770601272583, 8.059409141540527, 7.988025188446045, 7.202225208282471]

ROC AUC for Isolation Forest applied on Shuttle

[0.9522756656996257, 0.9522756656996257, 0.9516952213378863, 0.9528780466208355, 0.9528561100613655]

/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.

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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.390339136123657, 7.257411003112793, 7.819991111755371, 8.586779117584229, 7.9586098194122314]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9516952213378863, 0.9516952213378863, 0.9516952213378863]
```

```
/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.
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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.214524269104004, 7.662401914596558, 7.127188205718994, 7.423163890838623, 7.172269105911255]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522866339793609, 0.9516952213378863, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655]
```

```
/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.
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```
FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
```

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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.809195041656494, 7.567589044570923, 7.747357845
3063965, 8.277677059173584, 8.744305849075317]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9522756656996257, 0.9534365
544231049, 0.9511147769761468, 0.9522756656996257]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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Execution time of IsolationForest applied on Shutt
le (in second)
[7.849102020263672, 7.391727924346924, 7.057963132
858276, 7.347299098968506, 7.499239921569824]
ROC AUC for Isolation Forest applied on Shuttle
[0.9522756656996257, 0.9516952213378863, 0.9516952
213378863, 0.9517061896176212, 0.9528561100613655]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[7.338468790054321, 7.174046039581299, 7.238839149475098, 7.586956024169922, 7.333868026733398]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9516952213378863, 0.9522756656996257, 0.9528561100613655, 0.9517061896176212]

/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.

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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.29877495765686, 7.783124208450317, 7.8060860633  
8501, 7.8710339069366455, 7.394927024841309]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9528561100613655, 0.9516952  
213378863, 0.9522756656996257, 0.9522756656996257]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag  
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Execution time of IsolationForest applied on Shuttle (in second)

[7.485481262207031, 7.221795082092285, 7.5974342823028564, 7.366720676422119, 7.381523132324219]

ROC AUC for Isolation Forest applied on Shuttle

[0.9522756656996257, 0.9516952213378863, 0.9516952213378863, 0.9522756656996257, 0.9528561100613655]

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Execution time of IsolationForest applied on Shuttle (in second)

```
[7.5330212116241455, 7.560637950897217, 7.494244813919067, 7.082181930541992, 7.2418742179870605]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9522756656996257, 0.9522756656996257]
```

```
/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.
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Execution time of IsolationForest applied on Shuttle (in second)

```
[7.418258905410767, 7.534081697463989, 7.243840217
590332, 7.3088459968566895, 7.591854095458984]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9522756656996257, 0.9522756
656996257, 0.9528561100613655, 0.9528561100613655]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:417: DeprecationWarning: threshold_ attribute is deprecated in 0.20 and will be removed in 0.22.
```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.696716070175171, 7.7923359870910645, 7.718814134597778, 9.063477039337158, 8.256831884384155]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9516952213378863, 0.9528561100613655]
```

```
/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.
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.879742860794067, 7.974061012268066, 7.221677780151367, 7.341498136520386, 7.471080780029297]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9516952213378863, 0.9511147769761468, 0.9528561100613655, 0.9528561100613655]
```

```
/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.
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```
FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```
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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.4281699657440186, 7.354243993759155, 7.58442902
5650024, 7.85244607925415, 8.856542110443115]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9528561100613655, 0.9516952
213378863, 0.9522756656996257, 0.9528561100613655]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[8.595488786697388, 8.22825002670288, 7.590072154998779, 7.222859144210815, 7.7395689487457275]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9528561100613655, 0.9516952213378863, 0.9528670783411003]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.537745237350464, 7.1326680183410645, 7.440814018249512, 7.629269123077393, 7.905082941055298]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9522756656996257, 0.9528561100613655, 0.9505343326144072, 0.9528561100613655]
```

```
/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 predict method behavior.

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```

```
Execution time of IsolationForest applied on Shuttle (in second)
[8.262253046035767, 7.625825881958008, 9.084197998046875, 11.420223951339722, 36.78562021255493]
ROC AUC for Isolation Forest applied on Shuttle
[0.9528561100613655, 0.9516952213378863, 0.9522756656996257, 0.9522756656996257, 0.9522756656996257]
```

```
/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.
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```
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```

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FutureWarning)
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FutureWarning)
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```

```
FutureWarning)
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Execution time of IsolationForest applied on Shuttle (in second)

[35.45431613922119, 38.028496980667114, 37.169878005981445, 37.529184103012085, 30.202149152755737]

ROC AUC for Isolation Forest applied on Shuttle

[0.9534365544231049, 0.9516952213378863, 0.9522756656996257, 0.9528561100613655, 0.9528561100613655]

/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.

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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[12.349777912902832, 10.068740844726562, 9.5045907497406, 8.800004243850708, 8.467519998550415]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9522756656996257, 0.9528561100613655, 0.9516952213378863, 0.9516952213378863]
```

```
/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.
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```
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```

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Execution time of IsolationForest applied on Shuttle (in second)

[8.418452024459839, 8.608329057693481, 9.05904221534729, 11.179840087890625, 12.986430168151855]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9522756656996257, 0.9522756656996257, 0.9522756656996257, 0.9516952213378863]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[13.486601829528809, 13.98462200164795, 14.032320022583008, 15.116594076156616, 26.512725830078125]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9522756656996257, 0.9522756656996257, 0.9517061896176212, 0.9540169987848446]
```

```
/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.
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Execution time of IsolationForest applied on Shuttle (in second)

[19.718316078186035, 16.451406002044678, 13.14475703239441, 12.40139889717102, 12.12917709350586]

ROC AUC for Isolation Forest applied on Shuttle

[0.9511147769761468, 0.9522756656996257, 0.9522756656996257, 0.9528561100613655, 0.9516952213378863]

/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.

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```
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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[12.644355058670044, 14.169207096099854, 14.849133968353271, 13.846535205841064, 15.065332889556885]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9522756656996257, 0.9528561100613655, 0.9528670783411003, 0.9528561100613655]
```

```
/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.
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```

```
FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:417: DeprecationWarning: threshold_ attribute is deprecated in 0.20 and will be removed in 0.22.
```

```
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```
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[19.53222393989563, 20.40378999710083, 16.115206241607666, 16.003093004226685, 13.912309885025024]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9517061896176212, 0.9522756656996257, 0.9516952213378863, 0.9522756656996257]
```

```
/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.
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```
FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[13.143292903900146, 13.641403913497925, 14.813503
980636597, 14.700763940811157, 13.391571998596191]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9516952213378863, 0.9516952
213378863, 0.9516952213378863, 0.9516952213378863]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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default contamination parameter 0.1 will change in
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[13.691541910171509, 15.153295993804932, 16.741732835769653, 19.139795064926147, 14.837688207626343]
ROC AUC for Isolation Forest applied on Shuttle
[0.9528561100613655, 0.9516952213378863, 0.9516952213378863, 0.9511147769761468, 0.9516952213378863]
```

```
/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.
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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[14.005894184112549, 14.714438915252686, 14.583813905715942, 7.26915717124939, 7.0542051792144775]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9522756656996257, 0.9528561100613655, 0.9528561100613655, 0.9522756656996257]

/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.

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```
" be removed in 0.22.", DeprecationWarning)
```

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

```
[6.891844987869263, 6.670027017593384, 6.485530853  
271484, 6.014581918716431, 7.715816974639893]
```

```
ROC AUC for Isolation Forest applied on Shuttle
```

```
[0.9528561100613655, 0.9516952213378863, 0.9516952  
213378863, 0.9522756656996257, 0.9528561100613655]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag  
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```
FutureWarning)
```

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FutureWarning)
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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[8.9166841506958, 7.250292062759399, 9.820019006729126, 11.673755884170532, 7.599483013153076]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9534365544231049, 0.9511147769761468, 0.9516952213378863, 0.9528561100613655]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.773038148880005, 6.209227085113525, 6.064175844192505, 5.816880941390991, 5.931162118911743]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9511257452558817, 0.9516952213378863, 0.9522756656996257]
```

```
/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.
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FutureWarning)
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nd will be removed in 0.22.
```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.880075931549072, 6.090467214584351, 7.803833007
8125, 8.878969192504883, 8.648228168487549]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9522756656996257, 0.9522756
656996257, 0.9522756656996257, 0.9522756656996257]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.956077814102173, 6.251586675643921, 6.776845693588257, 7.507767200469971, 6.149458885192871]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9528670783411003, 0.9522866339793609, 0.9522756656996257, 0.9528561100613655]
```

```
/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.
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.428966045379639, 6.160474061965942, 6.810783863067627, 10.42520022392273, 11.978624105453491]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9528890149005704, 0.9528561100613655, 0.9516952213378863, 0.9528561100613655]
```

```
/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)
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```

```
" be removed in 0.22.", DeprecationWarning)
```

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

```
[8.264235019683838, 7.558905124664307, 7.136868953
704834, 6.867833137512207, 5.906799077987671]
```

```
ROC AUC for Isolation Forest applied on Shuttle
```

```
[0.9516952213378863, 0.9516952213378863, 0.9516952
213378863, 0.9522756656996257, 0.9516952213378863]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```

```
" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)
[5.73081374168396, 5.809834957122803, 6.094079971313477, 5.82343864440918, 5.718570947647095]
ROC AUC for Isolation Forest applied on Shuttle
[0.9516952213378863, 0.9528561100613655, 0.9528890149005704, 0.9516952213378863, 0.9528561100613655]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in
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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[6.242305040359497, 6.369794130325317, 5.844672918319702, 6.901733875274658, 6.867637872695923]

ROC AUC for Isolation Forest applied on Shuttle

[0.9522756656996257, 0.9528561100613655, 0.9522756656996257, 0.9528561100613655, 0.9516952213378863]

/Users/thesard/anaconda3/lib/python3.7/site-packag

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    " be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)  
[6.404558181762695, 7.217798948287964, 5.816239833831787, 5.852125883102417, 6.5508952140808105]  
ROC AUC for Isolation Forest applied on Shuttle  
[0.9517061896176212, 0.9522976022590958, 0.9516952213378863, 0.9517061896176212, 0.9516952213378863]

/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.

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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[6.369499921798706, 6.462493896484375, 8.000288963317871, 6.38547682762146, 6.058372259140015]

ROC AUC for Isolation Forest applied on Shuttle

[0.9516952213378863, 0.9516952213378863, 0.9522756656996257, 0.9522756656996257, 0.9528670783411003]

/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.

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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.0251240730285645, 6.560612916946411, 6.301178932189941, 8.56886601448059, 8.201468229293823]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528670783411003, 0.9522756656996257, 0.9516952213378863, 0.9534365544231049, 0.9511147769761468]
```

```
/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.
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FutureWarning)
```

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FutureWarning)
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FutureWarning)
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Execution time of IsolationForest applied on Shuttle (in second)

[7.7728590965271, 6.9036478996276855, 6.243099927902222, 6.58881402015686, 6.766337156295776]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9528561100613655, 0.9522756656996257, 0.9528561100613655, 0.9516952213378863]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.4964330196380615, 5.928498029708862, 6.6916563510894775, 6.34916615486145, 6.190413236618042]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9505343326144072, 0.9522756656996257, 0.9522756656996257, 0.9522756656996257, 0.9522756656996257]
```

```
/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.
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/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.
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```
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```

```
FutureWarning)
```

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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[5.989790916442871, 5.768070220947266, 6.84174919128418, 6.710567951202393, 7.394202947616577]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9522756656996257, 0.9505343326144072, 0.9528561100613655, 0.9522756656996257]

/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.

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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.278458118438721, 6.024049997329712, 6.09673810005188, 5.868176221847534, 6.050191164016724]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9528561100613655, 0.9522756656996257, 0.9522756656996257, 0.9522756656996257]
```

```
/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.
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.106306076049805, 6.00670599937439, 5.806407928466797, 5.988553762435913, 6.8301708698272705]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9516952213378863, 0.9522866339793609, 0.9516952213378863, 0.9522866339793609]
```

```
/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.
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```
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/Users/thesard/anaconda3/lib/python3.7/site-packag
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.364943981170654, 7.073072195053101, 7.022229909
896851, 6.381350040435791, 6.020211935043335]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9511147769761468, 0.9528561
100613655, 0.9505343326144072, 0.9522756656996257]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.288510322570801, 6.26572585105896, 6.591146945953369, 7.757319927215576, 6.717043161392212]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522866339793609, 0.9534365544231049, 0.9516952213378863, 0.9522756656996257, 0.9522756656996257]
```

```
/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.
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```
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```
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Execution time of IsolationForest applied on Shuttle (in second)

[6.642064094543457, 7.267536878585815, 6.931933164596558, 6.165798187255859, 6.036350965499878]

ROC AUC for Isolation Forest applied on Shuttle  
[0.9528561100613655, 0.9516952213378863, 0.9516952213378863, 0.9516952213378863, 0.9528561100613655]

/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.

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```
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.589477062225342, 6.13770604133606, 6.131127834320068, 6.7580790519714355, 6.98301100730896]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9516952213378863, 0.9516952213378863, 0.9516952213378863]
```

```
/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.
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Execution time of IsolationForest applied on Shuttle (in second)

[6.354737043380737, 6.95426607131958, 7.080382823944092, 6.291158676147461, 6.260157108306885]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9516952213378863, 0.9522866339793609, 0.9528561100613655, 0.9528561100613655]

/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.

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```
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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.359766721725464, 6.5846850872039795, 6.177348852157593, 5.764786243438721, 5.853003025054932]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9522756656996257, 0.9528561100613655, 0.9516952213378863]
```

```
/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.
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/Users/thesard/anaconda3/lib/python3.7/site-packag

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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.347954273223877, 6.5096118450164795, 5.91275691
986084, 6.733114957809448, 5.808748960494995]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9516952213378863, 0.9522756
656996257, 0.9522756656996257, 0.9522756656996257]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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Execution time of IsolationForest applied on Shuttle (in second)

```
[8.412743091583252, 6.2000861167907715, 6.650443077087402, 6.613651990890503, 6.250674247741699]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9516952213378863, 0.9528561100613655, 0.9516952213378863, 0.9528561100613655]
```

```
/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.
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Execution time of IsolationForest applied on Shuttle (in second)

[6.477027893066406, 6.673689842224121, 6.365664005279541, 6.574710130691528, 7.500362157821655]

ROC AUC for Isolation Forest applied on Shuttle

[0.9516952213378863, 0.9522756656996257, 0.9522756656996257, 0.9516952213378863, 0.9505343326144072]

/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.

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/Users/thesard/anaconda3/lib/python3.7/site-packag

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.894910097122192, 9.042126893997192, 6.610838890
075684, 6.329424858093262, 6.751965045928955]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9516952213378863, 0.9516952
213378863, 0.9516952213378863, 0.9517061896176212]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.232655048370361, 6.282137632369995, 5.911566734313965, 5.81144380569458, 5.8796610832214355]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9517061896176212, 0.9516952213378863, 0.9511147769761468, 0.9522756656996257, 0.9511147769761468]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.129637241363525, 6.8559510707855225, 7.083527088165283, 8.310896873474121, 6.30597186088562]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9540169987848446, 0.9522756656996257, 0.9522756656996257, 0.9528561100613655]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
```

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```

Execution time of IsolationForest applied on Shuttle (in second)  
[7.439443111419678, 6.648721933364868, 6.169531345367432, 5.994140863418579, 5.920557022094727]  
ROC AUC for Isolation Forest applied on Shuttle  
[0.9528561100613655, 0.9522756656996257, 0.9516952213378863, 0.9522756656996257, 0.9528670783411003]

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Execution time of IsolationForest applied on Shuttle (in second)

[6.097303152084351, 5.947952032089233, 5.83943510055542, 5.793933153152466, 5.9754979610443115]

ROC AUC for Isolation Forest applied on Shuttle

[0.9516952213378863, 0.9528561100613655, 0.9516952213378863, 0.9516952213378863, 0.9528561100613655]

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FutureWarning)

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:417: DeprecationWarning: threshold_ attribute is deprecated in 0.20 and will be removed in 0.22.
```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.867852210998535, 5.9157960414886475, 6.004635810852051, 5.946626901626587, 6.016723155975342]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9522756656996257, 0.9528561100613655, 0.9522866339793609, 0.9534365544231049]
```

```
/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)
```

```
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```

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FutureWarning)
```

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Execution time of IsolationForest applied on Shuttle (in second)

[6.437901973724365, 5.861806154251099, 6.397156238555908, 6.026767730712891, 5.898289918899536]

ROC AUC for Isolation Forest applied on Shuttle

[0.9522866339793609, 0.9511147769761468, 0.9516952213378863, 0.9528561100613655, 0.9516952213378863]

/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.

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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.562436103820801, 6.068636894226074, 6.768348932266235, 6.913155794143677, 6.861921072006226]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9522756656996257, 0.9516952213378863, 0.9528561100613655, 0.9528670783411003]
```

```
/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.
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Execution time of IsolationForest applied on Shuttle (in second)

[7.051580905914307, 6.688984155654907, 6.815474987030029, 7.735292911529541, 7.386708974838257]

ROC AUC for Isolation Forest applied on Shuttle

[0.9516952213378863, 0.9516952213378863, 0.9516952213378863, 0.9511147769761468, 0.9517061896176212]

/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.

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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.5279622077941895, 6.3398988246917725, 6.024942636489868, 8.666975021362305, 7.041527032852173]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9522756656996257, 0.9528561100613655, 0.9522756656996257, 0.9511147769761468]
```

```
/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.
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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.192102909088135, 6.242850065231323, 6.041193008422852, 7.011652946472168, 7.313457012176514]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9522756656996257, 0.9516952213378863, 0.9528561100613655, 0.9516952213378863]
```

```
/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.
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```
FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```
" be removed in 0.22.", DeprecationWarning)
```

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

```
[8.165452003479004, 7.8133931159973145, 6.23206400
87127686, 7.042840957641602, 6.960563898086548]
```

```
ROC AUC for Isolation Forest applied on Shuttle
```

```
[0.9528561100613655, 0.9528561100613655, 0.9522756
656996257, 0.9528561100613655, 0.9522756656996257]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.411880970001221, 7.210389137268066, 7.014359712600708, 8.177935123443604, 6.06720495223999]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9516952213378863, 0.9522756656996257, 0.9511147769761468, 0.9528561100613655]
```

```
/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.
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Execution time of IsolationForest applied on Shuttle (in second)

[7.534504175186157, 7.920777797698975, 7.426133155822754, 7.727094888687134, 8.564657926559448]

ROC AUC for Isolation Forest applied on Shuttle

[0.9516952213378863, 0.9528561100613655, 0.9522756656996257, 0.9516952213378863, 0.9516952213378863]

/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.

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```
" be removed in 0.22.", DeprecationWarning)
```

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

```
[7.544291973114014, 6.318772077560425, 6.521583080
291748, 5.739209890365601, 6.436115026473999]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9522756656996257, 0.9528561
100613655, 0.9528561100613655, 0.9516952213378863]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
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Execution time of IsolationForest applied on Shuttle (in second)

[6.361163139343262, 6.2010178565979, 6.0207905769348145, 5.833574056625366, 5.985443115234375]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9528561100613655, 0.9522866339793609, 0.9528561100613655, 0.9528561100613655]

/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.

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Execution time of IsolationForest applied on Shuttle (in second)

```
[6.370412111282349, 6.633282899856567, 6.792327880859375, 6.633286952972412, 6.327376842498779]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9516952213378863, 0.9516952213378863, 0.9511147769761468, 0.9528561100613655]
```

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/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.
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FutureWarning)
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/Users/thesard/anaconda3/lib/python3.7/site-packag

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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.23990797996521, 6.544729232788086, 6.5118150711
05957, 6.087719917297363, 6.21317195892334]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9528561100613655, 0.9516952
213378863, 0.9528561100613655, 0.9522756656996257]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.108896017074585, 6.415963888168335, 6.320388078689575, 5.95819616317749, 6.678068161010742]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9511147769761468, 0.9522756656996257, 0.9528561100613655, 0.9522756656996257, 0.9528561100613655]
```

```
/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.
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Execution time of IsolationForest applied on Shuttle (in second)

[6.909137010574341, 6.3282740116119385, 6.84611701965332, 7.776434898376465, 6.394345998764038]

ROC AUC for Isolation Forest applied on Shuttle

[0.9522756656996257, 0.9528561100613655, 0.9516952213378863, 0.9528561100613655, 0.9528561100613655]

/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.

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```

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

```
[6.655590057373047, 8.869380235671997, 8.306341886
520386, 6.951616048812866, 7.189397096633911]
```

```
ROC AUC for Isolation Forest applied on Shuttle
```

```
[0.9522756656996257, 0.9522756656996257, 0.9511147
769761468, 0.9511147769761468, 0.9516952213378863]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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Execution time of IsolationForest applied on Shuttle (in second)

```
[8.370216131210327, 6.188881158828735, 6.059394836425781, 6.1404078006744385, 6.74261212348938]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9516952213378863, 0.9522756656996257, 0.9528561100613655, 0.9522756656996257]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in
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Execution time of IsolationForest applied on Shuttle (in second)

[8.256906032562256, 6.542551040649414, 7.4133219718933105, 8.035346031188965, 7.01555609703064]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9516952213378863, 0.9528561100613655, 0.9516952213378863, 0.9517500627365613]

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    " be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)  
[5.997777938842773, 6.276078939437866, 5.982512950897217, 6.310427904129028, 7.009363174438477]  
ROC AUC for Isolation Forest applied on Shuttle  
[0.9522756656996257, 0.9522756656996257, 0.9528561100613655, 0.9522756656996257, 0.9522866339793609]

/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.

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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[6.62282395362854, 5.928891897201538, 9.036840915679932, 8.091968059539795, 7.888364791870117]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9522756656996257, 0.9528561100613655, 0.9528670783411003, 0.9528561100613655]

/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.

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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.679335832595825, 7.456387996673584, 7.342568874359131, 6.172400951385498, 5.840324878692627]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9516952213378863, 0.9516952213378863, 0.9516952213378863, 0.9528561100613655]
```

```
/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.
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```
FutureWarning)
```

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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[6.323932886123657, 8.05413031578064, 8.775637865066528, 6.119359016418457, 7.389439344406128]

ROC AUC for Isolation Forest applied on Shuttle

[0.9528561100613655, 0.9516952213378863, 0.9528670783411003, 0.9516952213378863, 0.9511147769761468]

/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.

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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.686964988708496, 6.3646416664123535, 6.3609299659729, 6.628443956375122, 6.8723671436309814]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9516952213378863, 0.9534365544231049, 0.9528561100613655, 0.9528561100613655]
```

```
/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.
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FutureWarning)
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Execution time of IsolationForest applied on Shuttle (in second)

[7.282220125198364, 6.606389999389648, 6.898102045059204, 7.066925048828125, 7.881088018417358]

ROC AUC for Isolation Forest applied on Shuttle

[0.9511257452558817, 0.9511147769761468, 0.9528561100613655, 0.9522756656996257, 0.9516952213378863]

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.502829074859619, 6.5087339878082275, 6.958184003829956, 6.050852060317993, 6.640492916107178]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9528561100613655, 0.9511147769761468, 0.9511147769761468, 0.9522756656996257]
```

```
/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.
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.001765966415405, 6.165302038192749, 7.228090047836304, 6.2727179527282715, 6.531893968582153]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9516952213378863, 0.9528561100613655, 0.9528561100613655, 0.9528561100613655]
```

```
/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.
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```
FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.863240957260132, 6.753769874572754, 6.148587942
123413, 6.005748987197876, 6.132258892059326]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9516952213378863, 0.9505343
326144072, 0.9516952213378863, 0.9528561100613655]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```
" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[6.033157110214233, 5.834211111068726, 6.097094774
246216, 6.085755825042725, 5.905087947845459]
ROC AUC for Isolation Forest applied on Shuttle
[0.9528561100613655, 0.9528561100613655, 0.9522866
339793609, 0.9516952213378863, 0.9516952213378863]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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[6.661071062088013, 6.39999794960022, 6.016890287399292, 6.556842088699341, 6.997863054275513]  
ROC AUC for Isolation Forest applied on Shuttle  
[0.9516952213378863, 0.9528561100613655, 0.9534365544231049, 0.9516952213378863, 0.9516952213378863]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[9.299079895019531, 8.024298906326294, 7.894573926  
925659, 6.577469110488892, 6.9414451122283936]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9528561100613655, 0.9534475  
2270284, 0.9516952213378863, 0.9528561100613655]
```

```
/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  
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```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag  
es/sklearn/ensemble/iforest.py:223: FutureWarning:  
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```
FutureWarning)
```

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Execution time of IsolationForest applied on Shuttle (in second)

[7.591961145401001, 6.8070759773254395, 8.53626799583435, 8.80275011062622, 7.830450773239136]

ROC AUC for Isolation Forest applied on Shuttle

[0.9516952213378863, 0.9517061896176212, 0.9516952213378863, 0.9511147769761468, 0.9522756656996257]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.869778871536255, 7.2145538330078125, 7.542582035064697, 6.411825895309448, 6.418945074081421]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9516952213378863, 0.9516952213378863, 0.9528561100613655, 0.9505343326144072]
```

```
/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.
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FutureWarning)

/Users/thesard/anaconda3/lib/python3.7/site-packag

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.163771152496338, 5.289520978927612, 5.929565906
524658, 5.4144580364227295, 5.451024055480957]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9511147769761468, 0.9516952
213378863, 0.9511257452558817, 0.9517061896176212]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.425754070281982, 5.892866134643555, 5.72490382194519, 6.210923910140991, 6.152892112731934]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9528561100613655, 0.9528561100613655, 0.9516952213378863, 0.9516952213378863]
```

```
/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.
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Execution time of IsolationForest applied on Shuttle (in second)

[5.381699085235596, 5.291127920150757, 5.2688188552856445, 5.363124132156372, 6.495855093002319]

ROC AUC for Isolation Forest applied on Shuttle

[0.9523743802172409, 0.9528561100613655, 0.9522756656996257, 0.9516952213378863, 0.9516952213378863]

/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.

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/Users/thesard/anaconda3/lib/python3.7/site-packag



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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.334780216217041, 5.3124778270721436, 5.77940201
7593384, 6.201607942581177, 6.121257066726685]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9528561100613655, 0.9522756
656996257, 0.9522756656996257, 0.9528561100613655]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.459120750427246, 6.454635143280029, 6.173654079437256, 6.0135040283203125, 6.642045974731445]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9522756656996257, 0.9528561100613655, 0.9516952213378863, 0.9534365544231049]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.183320999145508, 6.517491102218628, 5.831312894821167, 5.323782920837402, 6.003864049911499]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9540169987848446, 0.9516952213378863, 0.9522756656996257, 0.9511147769761468, 0.9511147769761468]
```

```
/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 predict method behavior.

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nd will be removed in 0.22.
    " be removed in 0.22.", DeprecationWarning)
```



```
Execution time of IsolationForest applied on Shuttle (in second)
[6.89654803276062, 6.702567100524902, 6.200892925262451, 5.520593881607056, 5.4553258419036865]
ROC AUC for Isolation Forest applied on Shuttle
[0.9522756656996257, 0.9528670783411003, 0.9516952213378863, 0.9516952213378863, 0.9511147769761468]
```

```
/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.
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```
FutureWarning)
```

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Execution time of IsolationForest applied on Shuttle (in second)

[5.463917970657349, 5.48274302482605, 5.5641748905181885, 5.59381103515625, 6.627718210220337]

ROC AUC for Isolation Forest applied on Shuttle

[0.9516952213378863, 0.9511147769761468, 0.9522756656996257, 0.9522756656996257, 0.9516952213378863]

/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.

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Execution time of IsolationForest applied on Shuttle (in second)

```
[6.076538801193237, 5.2574782371521, 5.456069231033325, 5.404989957809448, 5.37586784362793]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528780466208355, 0.9528561100613655, 0.9516952213378863, 0.9528561100613655, 0.9516952213378863]
```

```
/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.
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FutureWarning)
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Execution time of IsolationForest applied on Shuttle (in second)

[5.560405015945435, 5.423792839050293, 5.323793888092041, 5.42507004737854, 5.450117111206055]

ROC AUC for Isolation Forest applied on Shuttle

[0.9522756656996257, 0.9522756656996257, 0.9516952213378863, 0.9522756656996257, 0.9516952213378863]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.623960971832275, 6.012320041656494, 6.359859228134155, 6.040817022323608, 5.352812051773071]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522756656996257, 0.9528561100613655, 0.9516952213378863, 0.9522756656996257, 0.9516952213378863]
```

```
/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.
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Execution time of IsolationForest applied on Shuttle (in second)

[5.7564311027526855, 6.035185098648071, 6.04248309135437, 6.462507009506226, 6.598191022872925]

ROC AUC for Isolation Forest applied on Shuttle

[0.9522756656996257, 0.9528561100613655, 0.9528561100613655, 0.9516952213378863, 0.9528561100613655]

/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.

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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.909110069274902, 6.114394664764404, 6.2356672286987305, 5.997589111328125, 5.8151679039001465]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9516952213378863, 0.9505343326144072, 0.9516952213378863, 0.9516952213378863]
```

```
/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.
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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.074885129928589, 5.420690059661865, 5.373424053192139, 5.786346912384033, 5.621066093444824]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9511147769761468, 0.9528561100613655, 0.9516952213378863, 0.9517061896176212]
```

```
/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.
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```
FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.659944772720337, 6.000961065292358, 5.601545095
443726, 5.373540163040161, 5.824357986450195]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9517061896176212, 0.9522756656996257, 0.9516952
213378863, 0.9522756656996257, 0.9516952213378863]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.824214935302734, 6.078169107437134, 6.142045021057129, 6.422914028167725, 6.8715126514434814]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9528561100613655, 0.9516952213378863, 0.9522756656996257, 0.9522756656996257]
```

```
/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.
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```
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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[6.0382609367370605, 5.715473175048828, 5.660186052322388, 5.583729028701782, 5.408103942871094]

ROC AUC for Isolation Forest applied on Shuttle

[0.9517061896176212, 0.9516952213378863, 0.9511367135356167, 0.9516952213378863, 0.9516952213378863]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

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

```
[5.498970031738281, 5.545107126235962, 5.583693981  
170654, 5.85207724571228, 5.483551979064941]
```

```
ROC AUC for Isolation Forest applied on Shuttle
```

```
[0.9522756656996257, 0.9516952213378863, 0.9522756  
656996257, 0.9516952213378863, 0.9516952213378863]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag  
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Execution time of IsolationForest applied on Shuttle (in second)

[5.506649017333984, 6.112850904464722, 5.4889421463012695, 5.412344932556152, 5.346766948699951]

ROC AUC for Isolation Forest applied on Shuttle

[0.9516952213378863, 0.9516952213378863, 0.9522756656996257, 0.9522756656996257, 0.9516952213378863]

/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.

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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.388840913772583, 5.515772104263306, 5.399543762207031, 5.740605115890503, 5.807425022125244]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9523634119375058, 0.9511147769761468, 0.9516952213378863, 0.9517061896176212]
```

```
/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.
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FutureWarning)
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.63219690322876, 6.878661155700684, 6.9960560798
64502, 6.59757399559021, 6.114796876907349]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9522866339793609, 0.9522756656996257, 0.9517171
578973563, 0.9516952213378863, 0.9516952213378863]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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/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.
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```
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.724290132522583, 6.286373138427734, 5.773534774780273, 5.830357074737549, 5.308845043182373]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9522756656996257, 0.9516952213378863, 0.9522756656996257, 0.9522756656996257]
```

```
/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.
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.32730507850647, 5.389456033706665, 5.587575197219849, 5.254982233047485, 5.347797155380249]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9517061896176212, 0.9511147769761468, 0.9522756656996257, 0.9516952213378863, 0.9522866339793609]
```

```
/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)
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```

```
" be removed in 0.22.", DeprecationWarning)
```

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

```
[5.307767152786255, 5.30988883972168, 5.3724720478
05786, 5.805532217025757, 6.007061004638672]
```

```
ROC AUC for Isolation Forest applied on Shuttle
```

```
[0.9522866339793609, 0.9516952213378863, 0.9516952
213378863, 0.9522756656996257, 0.9516952213378863]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```
" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shutt
le (in second)
[6.303957939147949, 5.748091220855713, 5.897823333
740234, 5.963904857635498, 6.5026631355285645]
ROC AUC for Isolation Forest applied on Shuttle
[0.9534365544231049, 0.9522756656996257, 0.9517061
896176212, 0.9528561100613655, 0.9511147769761468]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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Execution time of IsolationForest applied on Shuttle (in second)

[6.4787750244140625, 5.861496686935425, 5.814213275909424, 5.49963903427124, 5.928514003753662]

ROC AUC for Isolation Forest applied on Shuttle

[0.9522756656996257, 0.9516952213378863, 0.9516952213378863, 0.9522756656996257, 0.9528670783411003]

/Users/thesard/anaconda3/lib/python3.7/site-packag

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Execution time of IsolationForest applied on Shuttle (in second)  
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ROC AUC for Isolation Forest applied on Shuttle  
[0.9516952213378863, 0.9516952213378863, 0.9511147769761468, 0.9522756656996257, 0.9528561100613655]

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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[5.752091884613037, 5.4822611808776855, 5.520656108856201, 6.143748760223389, 5.699744939804077]

ROC AUC for Isolation Forest applied on Shuttle

[0.9522866339793609, 0.9516952213378863, 0.9516952213378863, 0.9516952213378863, 0.9528561100613655]

/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.

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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.971656322479248, 5.946441888809204, 6.07025408744812, 5.761163949966431, 5.466091156005859]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9516952213378863, 0.9516952213378863, 0.9522756656996257, 0.9516952213378863]
```

```
/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.
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```
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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[6.2218828201293945, 5.68822717666626, 5.957951068878174, 5.958492994308472, 6.213623046875]

ROC AUC for Isolation Forest applied on Shuttle

[0.9522756656996257, 0.9522756656996257, 0.9511147769761468, 0.9516952213378863, 0.9522756656996257]

/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.

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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.150824069976807, 5.99884295463562, 6.0331830978393555, 5.441993951797485, 5.38978910446167]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9522756656996257, 0.9516952213378863, 0.9517061896176212, 0.9511147769761468]
```

```
/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.
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Execution time of IsolationForest applied on Shuttle (in second)

[5.350830078125, 5.870940923690796, 5.847965955734253, 6.580203056335449, 5.807773113250732]

ROC AUC for Isolation Forest applied on Shuttle

[0.9511147769761468, 0.9528561100613655, 0.9516952213378863, 0.9516952213378863, 0.9528561100613655]

/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.

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Execution time of IsolationForest applied on Shuttle (in second)

```
[6.167714834213257, 5.831933975219727, 5.524860858917236, 6.305643081665039, 5.744762182235718]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9528561100613655, 0.9517061896176212, 0.9528561100613655, 0.9516952213378863]
```

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/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.
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```
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.826818943023682, 5.540571928024292, 6.104310989379883, 5.727169990539551, 5.686525344848633]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9528561100613655, 0.9516952213378863, 0.9516952213378863, 0.9516952213378863, 0.9516952213378863]
```

```
/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.
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```
FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packag
```



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" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.682880163192749, 5.932780981063843, 6.542663812
637329, 5.457688093185425, 5.635227203369141]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9511147769761468, 0.9522756656996257, 0.9516952
213378863, 0.9528561100613655, 0.9516952213378863]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.711343050003052, 5.71228814125061, 5.805556774139404, 5.963942050933838, 5.821818113327026]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9511147769761468, 0.9522756656996257, 0.9516952213378863, 0.9516952213378863]
```

```
/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.
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" be removed in 0.22.", DeprecationWarning)  
  
Execution time of IsolationForest applied on Shuttle (in second)  
[5.800804138183594, 5.689280986785889, 5.4648027420043945, 5.388778924942017, 5.580643892288208]  
ROC AUC for Isolation Forest applied on Shuttle  
[0.9516952213378863, 0.9516952213378863, 0.9511147769761468, 0.9516952213378863, 0.9522866339793609]

/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.

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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.601252794265747, 6.284000873565674, 6.017191886  
9018555, 6.505535840988159, 6.113444089889526]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9511147769761468, 0.9516952  
213378863, 0.9516952213378863, 0.9528561100613655]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag  
es/sklearn/ensemble/iforest.py:213: FutureWarning:  
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```
FutureWarning)
```

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FutureWarning)
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Execution time of IsolationForest applied on Shuttle (in second)

[5.649187088012695, 5.71366024017334, 5.894404888153076, 5.74035906791687, 5.922098159790039]

ROC AUC for Isolation Forest applied on Shuttle

[0.9516952213378863, 0.9505343326144072, 0.9528561100613655, 0.9516952213378863, 0.9522756656996257]

/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.

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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.769156217575073, 5.905030965805054, 5.911828994750977, 5.440783977508545, 7.158853769302368]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9516952213378863, 0.9517061896176212, 0.9522756656996257, 0.9522756656996257]
```

```
/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.
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```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[5.937416315078735, 6.167517185211182, 6.613139867
782593, 6.047067165374756, 6.547752380371094]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9522756656996257, 0.9522756
656996257, 0.9522866339793609, 0.9522756656996257]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.237789869308472, 6.378114938735962, 6.36014986038208, 6.4373602867126465, 5.600008964538574]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9516952213378863, 0.9528561100613655, 0.9522756656996257, 0.9516952213378863]
```

```
/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.
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Execution time of IsolationForest applied on Shuttle (in second)

[5.7817771434783936, 6.5065648555755615, 8.712241172790527, 8.695052862167358, 8.048969030380249]

ROC AUC for Isolation Forest applied on Shuttle

[0.9516952213378863, 0.9516952213378863, 0.9516952213378863, 0.9528670783411003, 0.9522756656996257]

/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.

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```
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```

Execution time of IsolationForest applied on Shuttle (in second)

```
[8.030828952789307, 7.402791976928711, 8.474109888
076782, 6.899712085723877, 6.848374128341675]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9516952213378863, 0.9516952
213378863, 0.9528561100613655, 0.9516952213378863]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag
es/sklearn/ensemble/iforest.py:213: FutureWarning:
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```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[7.255906105041504, 6.216746807098389, 9.154850006103516, 6.956228017807007, 6.145346164703369]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9516952213378863, 0.9517061896176212, 0.9522866339793609, 0.9511147769761468]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:213: FutureWarning: default contamination parameter 0.1 will change in
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```

```
FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packages/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-packages/sklearn/ensemble/iforest.py:417: DeprecationWarning: threshold_ attribute is deprecated in 0.20 and will be removed in 0.22.
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```
" be removed in 0.22.", DeprecationWarning)
/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.
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```
FutureWarning)
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```
FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:417: DeprecationWarning: threshold_ attribute is deprecated in 0.20 and will be removed in 0.22.
```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.51909613609314, 6.598208904266357, 7.306484937667847, 6.397081136703491, 6.800962686538696]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9511147769761468, 0.9516952213378863, 0.9511147769761468, 0.9522756656996257, 0.9522756656996257]
```

```
/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 predict method behavior.

FutureWarning)

/Users/thesard/anaconda3/lib/python3.7/site-packages/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.

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FutureWarning)

```
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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
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ning: threshold_ attribute is deprecated in 0.20 a
nd will be removed in 0.22.
    " be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)  
[6.8329949378967285, 7.154588937759399, 7.506136178970337, 7.574402093887329, 7.076604843139648]  
ROC AUC for Isolation Forest applied on Shuttle  
[0.9516952213378863, 0.9516952213378863, 0.9511147769761468, 0.9516952213378863, 0.9516952213378863]

/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)

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/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)

/Users/thesard/anaconda3/lib/python3.7/site-packages/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-packages/sklearn/ensemble/iforest.py:417: DeprecationWarning: threshold\_ attribute is deprecated in 0.20 and will be removed in 0.22.

" be removed in 0.22.", DeprecationWarning)

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/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.

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/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:417: DeprecationWarning: threshold\_ attribute is deprecated in 0.20 and will be removed in 0.22.

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" be removed in 0.22.", DeprecationWarning)

Execution time of IsolationForest applied on Shuttle (in second)

[8.066596031188965, 6.2738659381866455, 8.5015549659729, 8.34735107421875, 6.770502328872681]

ROC AUC for Isolation Forest applied on Shuttle

[0.9516952213378863, 0.9511147769761468, 0.9528561100613655, 0.9522756656996257, 0.9516952213378863]

/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.

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FutureWarning)

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/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.

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FutureWarning)

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/ensemble/iforest.py:417: DeprecationWarning: threshold_ attribute is deprecated in 0.20 and will be removed in 0.22.
```

```
" be removed in 0.22.", DeprecationWarning)
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[6.47500205039978, 6.579102993011475, 6.236034870147705, 6.263751029968262, 5.956799030303955]
```

ROC AUC for Isolation Forest applied on Shuttle

```
[0.9516952213378863, 0.9516952213378863, 0.9517061896176212, 0.9511147769761468, 0.9522756656996257]
```

In [8]:

```
print("Execution time of IsolationForest applied on Shuttle (in second)")
print(averages_executions_time_IF_Shuttle)
plt.plot(range(100, len(X_Shuttle), 100), averages_executions_time_IF_Shuttle, "g-", label="IForest on Shuttle")
#plt.axis([0, 1, 0, 1])
plt.xlabel('max_samples')
plt.ylabel('Execution time')
plt.legend(loc="best")
plt.show()
```

Execution time of IsolationForest applied on Shuttle (in second)

```
[3.5477282047271728, 3.9226028442382814, 4.272112941741943, 3.2975602626800535, 3.4408787727355956, 3.8023194313049316, 3.7811569213867187, 3.592048312335204, 3.65282301902771, 3.8772323608398436, 4.698689365386963, 3.85642466545105, 4.40067138671875, 4.086485099792481, 3.9223703861236574, 3.8970434188842775, 3.9742950916290285, 3.7452354431152344, 4.128338384628296, 3.685234880447388, 4.055926513671875, 3.9528275966644286, 3.956861162185669, 3.9127503871917724, 4.056956577301025, 3.891107416152954, 3.916246175765991, 3.9156417846679688, 4.041038990020752, 3.9453048706054688, 4.404048824310303, 4.712860012054444, 4.249695634841919, 4.102525758743286, 4.147455501556396, 4.20218825340271, 4.096425867080688, 4.121721935272217, 3.9298277854919434, 4.167852735519409, 4.349965667724609, 4.286297178268432, 4.472400903701782, 4.220876789093017, 4.1971409797668455, 4.231305503845215, 4.32420859336853, 4.2187933921813965, 4.243699407577514, 4.46
```

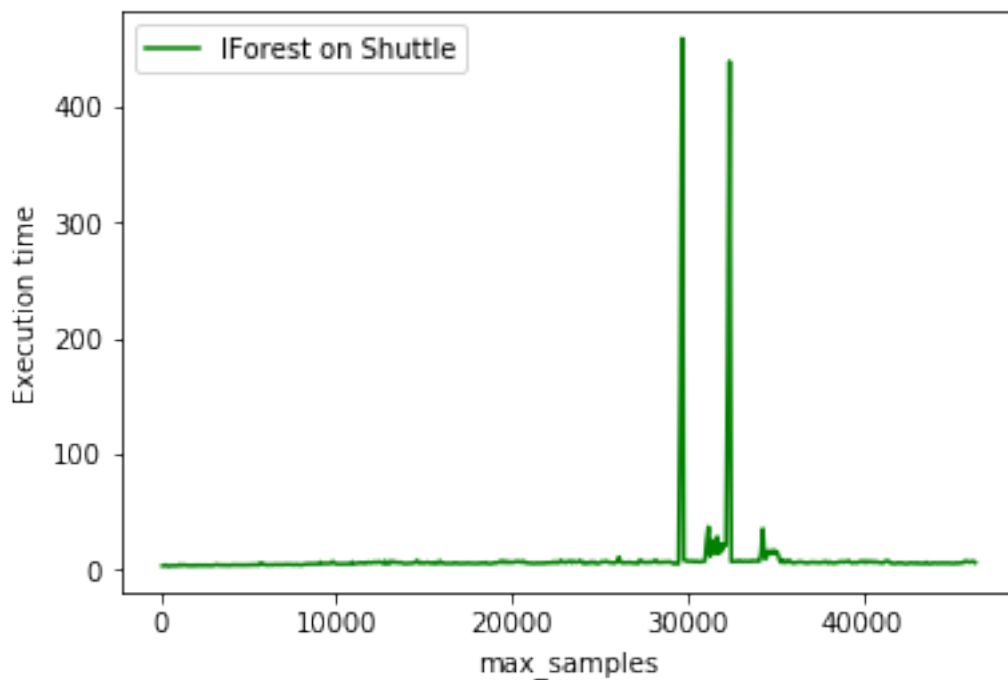
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In [9]:

```
print("ROC AUC for Isolation Forest applied on Shuttle")
print(averages_roc_auc_IF_Shuttle)
print("La valeur max est "+str(max(averages_roc_auc_IF_Shuttle
))+ " à l'index "+str(averages_roc_auc_IF_Shuttle.index(max(ave
rages_roc_auc_IF_Shuttle))))
plt.plot(range(100, len(X_Shuttle), 100), averages_roc_auc_IF_
Shuttle, "g-", label="ROC AUC of IForest on Shuttle")
#plt.axis([0, 1, 0, 1])
plt.xlabel('max_samples')
plt.ylabel('AUC')
plt.legend(loc="best")
plt.show()
```

```
ROC AUC for Isolation Forest applied on Shuttle
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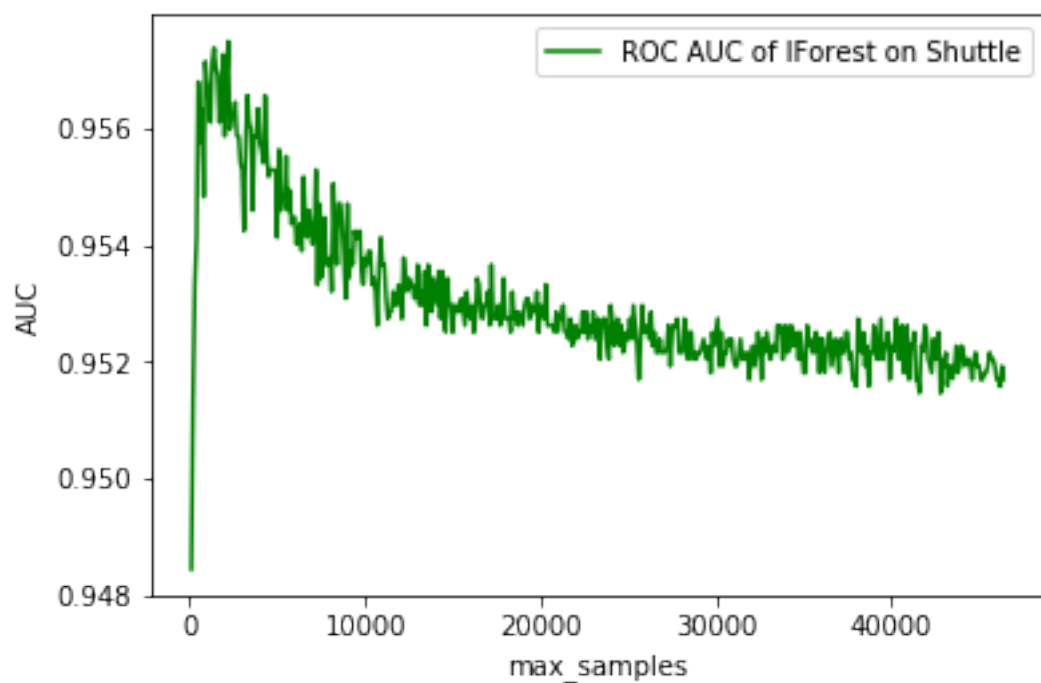
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La valeur max est 0.9574996649552818 à l'index 21



**Interprétation du résultat de IsolationForest sur Shuttle**



### ***Faisant varier n\_estimators***

Le temps d'exécution de IForest n'est pas lié à la variation de contamination (le taux d'anomalies dans le jeu de données). Par contre en ce qui concerne l'aire sous la courbe ROC, la meilleure performance est arrivée quand contamination est à 0,1. 0,1 est d'ailleurs la valeur par défaut de contamination au niveau de scikit-learn. Conclusion: Refaire l'exercice en faisant varier cette fois-ci n\_estimators (le nombre d'estimateurs de l'ensemble à utiliser pour tester l'aberrance des observations).

Avec n\_estimators entre 50 et 300, on remarque que le temps d'exécution augmente au fur et à mesure que le nombre d'estimateurs augmente. Concernant la performance, la meilleure estimation a été obtenue pour un taux de AUC = 0.9530882878060613 avec n\_estimators = 70 ==> (50+2\*10) A noter que quelque soit la valeur de n\_estimators, la AUC est toujours supérieure à 0,95

Avec n\_estimators entre 10 et 300, on remarque que le temps d'exécution augmente au fur et à mesure que le nombre d'estimateurs augmente. Concernant la performance, la meilleure estimation a été obtenue pour un taux de AUC = 0.9540169987848446 avec n\_estimators = 90 ==> ((8+1)\*10) avec un CPU Time de 3.2488044261932374 A noter que quelque soit la valeur de n\_estimators, la AUC est toujours supérieure à 0,95

### ***Faisant varier max\_samples***

Avec max\_samples entre 100 et len(X\_Shuttle) pas 100, le temps d'exécution reste assez constant soit [3,8] sauf quelques cas très minoritaires de hausse. Considérant l'aire sous la courbe ROC, celle-ci a atteint sa plus haute valeur soit 0.9574996649552818 à max\_samples = 2200((21+1)\*100) après quoi la qualité de la prédiction a diminué. Néanmoins, il faut noter qu'en général, la AUC est toujours supérieure à 0,95.

## **Exécution de OC-SVM sur Shuttle**

In [19]:

```
averages_executions_time_OCSVM_Shuttle = []
averages_roc_auc_OCSVM_Shuttle = []

for j in frange(0.1, 1., 0.1):
    nu = j
    executions_time_OCSVM_Shuttle = []
    roc_auc_OCSVM_Shuttle = []
    for i in range(5):
        start_OCSVM_Shuttle = time()

        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
        exec_time_OCSVM_Shuttle = time() - start_OCSVM_Shuttle
        executions_time_OCSVM_Shuttle.append(exec_time_OCSVM_Shuttle)

        # Calcul de l'aire sous la courbe ROC
        auc_OCSVM_Shuttle = roc_auc_score(y_transform_Shuttle,
        y_pred_OCSVM_Shuttle)
        roc_auc_OCSVM_Shuttle.append(auc_OCSVM_Shuttle)

    print("Execution time of OC-SVM applied on Shuttle (in seconds)")
    print(executions_time_OCSVM_Shuttle)
    print("ROC AUC for OC-SVM applied on Shuttle")
    print(roc_auc_OCSVM_Shuttle)
    averages_executions_time_OCSVM_Shuttle.append(statistics.mean(executions_time_OCSVM_Shuttle))
    averages_roc_auc_OCSVM_Shuttle.append(statistics.mean(roc_auc_OCSVM_Shuttle))
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packag  
es/ipykernel_launcher.py:34: MatplotlibDeprecation  
Warning: numpy.arange
```

```
/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/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/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/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/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)
```

Execution time of OC-SVM applied on Shuttle (in se  
cond)

```
[329.46220993995667, 261.47730708122253, 274.28071  
904182434, 245.17911291122437, 240.5820107460022]
```

ROC AUC for OC-SVM applied on Shuttle

```
[0.6188546777389493, 0.6188546777389493, 0.6188546  
777389493, 0.6188546777389493, 0.6188546777389493]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

Execution time of OC-SVM applied on Shuttle (in second)

```
[218.47312903404236, 216.3624849319458, 214.21477723121643, 215.6682789325714, 214.08669090270996]
```

ROC AUC for OC-SVM applied on Shuttle

```
[0.7269955947990666, 0.7269955947990666, 0.7269955947990666, 0.7269955947990666, 0.7269955947990666]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

Execution time of OC-SVM applied on Shuttle (in second)

```
[191.5847761631012, 184.71183609962463, 180.26945781707764, 189.2221701145172, 181.08830785751343]
```

ROC AUC for OC-SVM applied on Shuttle

```
[0.7737174183377845, 0.7737174183377845, 0.7737174183377845, 0.7737174183377845, 0.7737174183377845]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

Execution time of OC-SVM applied on Shuttle (in second)

```
[161.18653416633606, 160.5630328655243, 160.26079177856445, 160.88182997703552, 161.40579509735107]
```

ROC AUC for OC-SVM applied on Shuttle

```
[0.775169428691041, 0.775169428691041, 0.775169428691041, 0.775169428691041, 0.775169428691041]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

Execution time of OC-SVM applied on Shuttle (in second)

```
[150.68664383888245, 150.58169770240784, 148.8878152370453, 148.7774007320404, 149.51005792617798]
```

ROC AUC for OC-SVM applied on Shuttle

```
[0.7442227397273692, 0.7442227397273692, 0.7442227397273692, 0.7442227397273692, 0.7442227397273692]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

Execution time of OC-SVM applied on Shuttle (in second)

```
[141.95292973518372, 141.27181887626648, 148.45246386528015, 145.09825491905212, 144.94975304603577]
```

ROC AUC for OC-SVM applied on Shuttle

```
[0.7015329207794384, 0.7015329207794384, 0.7015329207794384, 0.7015329207794384, 0.7015329207794384]
```



```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

Execution time of OC-SVM applied on Shuttle (in second)

```
[138.45889115333557, 136.31735110282898, 136.81975293159485, 138.9244029521942, 143.10618805885315]
```

ROC AUC for OC-SVM applied on Shuttle

```
[0.6525248979949985, 0.6525248979949985, 0.6525248979949985, 0.6525248979949985, 0.6525248979949985]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

Execution time of OC-SVM applied on Shuttle (in second)

```
[121.23537707328796, 121.62225794792175, 121.03575110435486, 122.10104298591614, 121.69169592857361]
```

ROC AUC for OC-SVM applied on Shuttle

```
[0.601708857982714, 0.601708857982714, 0.601708857982714, 0.601708857982714, 0.601708857982714]
```

```
/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/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/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/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/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)
```

Execution time of OC-SVM applied on Shuttle (in se  
cond)

```
[119.410649061203, 112.79455494880676, 117.1170990  
4670715, 111.87071490287781, 120.11324286460876]
```

ROC AUC for OC-SVM applied on Shuttle

```
[0.5511121835651296, 0.5511121835651296, 0.5511121  
835651296, 0.5511121835651296, 0.5511121835651296]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
"avoid this warning.", FutureWarning)
```

```
Execution time of OC-SVM applied on Shuttle (in seconds)
```

```
[107.6783459186554, 108.68707871437073, 107.13427805900574, 111.51461815834045, 108.39957904815674]
```

```
ROC AUC for OC-SVM applied on Shuttle
```

```
[0.5, 0.5, 0.5, 0.5, 0.5]
```

## Résultat de OC-SVM sur shuttle

In [22]:

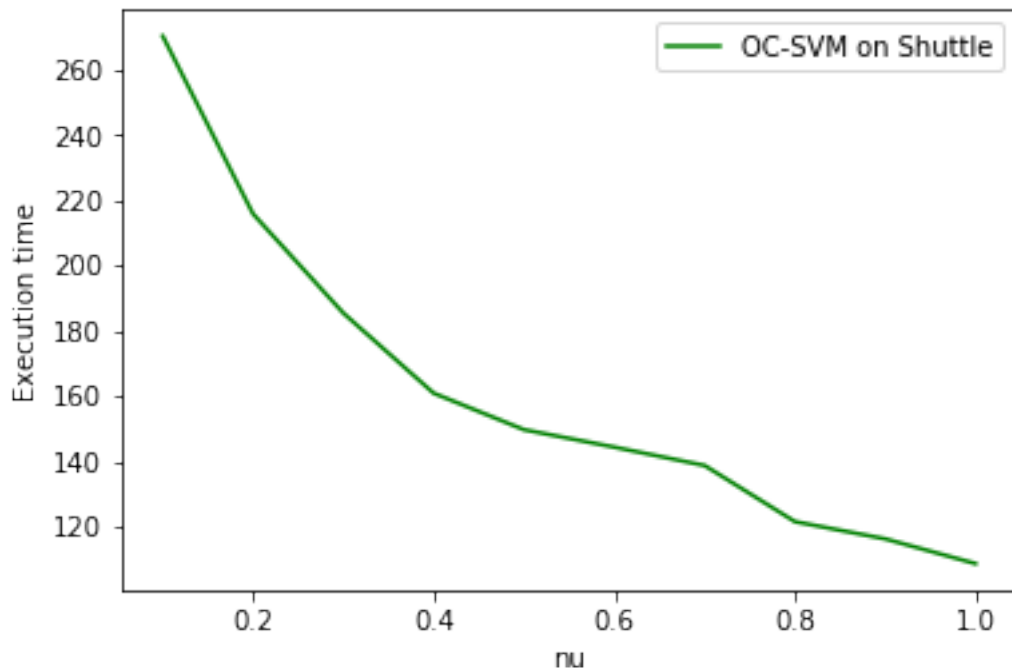
```
print("Execution time of OC-SVM applied on Shuttle (in second)
")
print(averages_executions_time_OCSVM_Shuttle)
plt.plot(frange(0.1, 1., 0.1), averages_executions_time_OCSVM_
Shuttle, "g-", label="OC-SVM on Shuttle")
#plt.axis([0, 1, 0, 1])
plt.xlabel('nu')
plt.ylabel('Execution time')
plt.legend(loc="best")
plt.show()
```

Execution time of OC-SVM applied on Shuttle (in second)

```
[270.19627194404603, 215.7610722064972, 185.375309
61036683, 160.8595967769623, 149.6887230873108, 14
4.34504408836364, 138.72531723976135, 121.53722500
801086, 116.2612521648407, 108.68277997970581]
```

/Users/thesard/anaconda3/lib/python3.7/site-packages/ipykernel\_launcher.py:3: MatplotlibDeprecationWarning: numpy.arange

This is separate from the ipykernel package so we can avoid doing imports until



In [25]:

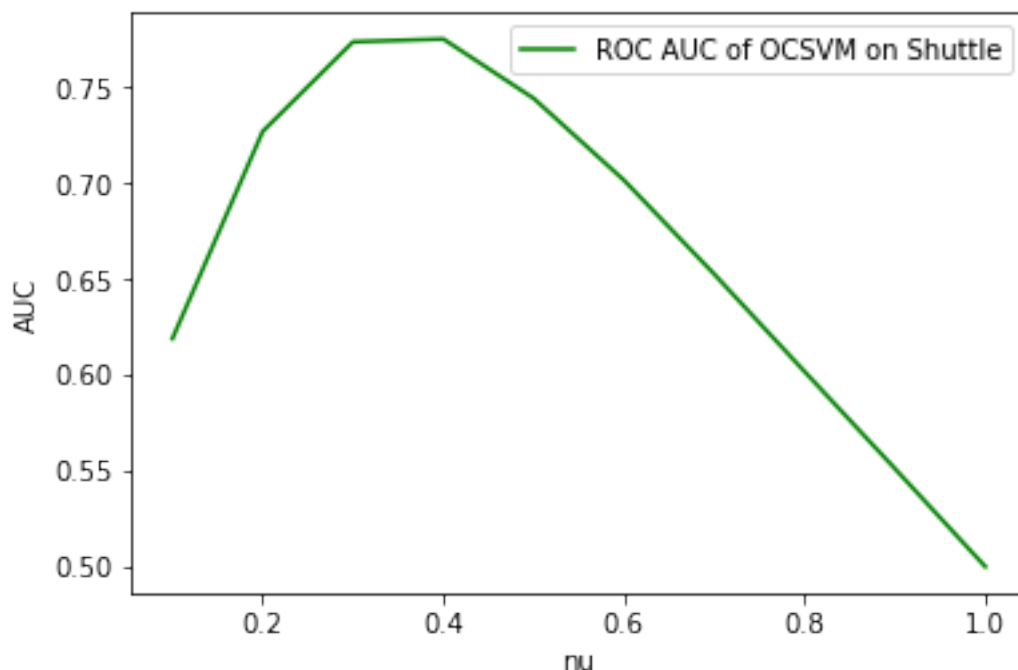
```
print("ROC AUC for OC-SVM applied on Shuttle")
print(averages_roc_auc_OCSVM_Shuttle)
plt.plot(frange(0.1, 1., 0.1), averages_roc_auc_OCSVM_Shuttle,
"b-", label="ROC AUC of OCSVM on Shuttle")
#plt.axis([0, 1, 0, 1])
plt.xlabel('nu')
plt.ylabel('AUC')
plt.legend(loc="best")
plt.show()
```

ROC AUC for OC-SVM applied on Shuttle

```
[0.6188546777389493, 0.7269955947990666, 0.7737174
183377845, 0.775169428691041, 0.7442227397273692,
0.7015329207794384, 0.6525248979949985, 0.60170885
7982714, 0.5511121835651296, 0.5]
```

/Users/thesard/anaconda3/lib/python3.7/site-packag  
es/ipykernel\_launcher.py:3: MatplotlibDeprecationW  
arning: numpy.arange

This is separate from the ipykernel package so w  
e can avoid doing imports until



**Interprétation du résultat de OC-SVM sur Shuttle**

Plus la valeur de  $\nu$  augmente plus le temps d'exécution diminue. OC-SVM est donc plus rapide sur Shuttle avec un  $\nu$  plus grand. Mais, cela n'entraîne pas un bon résultat de la méthode. Puisqu'à partir d'un  $\nu$  de 0.5, la prédiction de l'algorithme devient de plus en plus aléatoire. La meilleure performance est atteinte à  $\nu = 0.4$

## Exécution de LOF sur Shuttle

In [35]:

```
averages_executions_time_LOF_Shuttle = []
averages_roc_auc_LOF_Shuttle = []

for j in range(5, 200, 5):
    n_neighbors = j
    executions_time_LOF_Shuttle = []
    roc_auc_LOF_Shuttle = []
    for i in range(5):
        start_LOF_Shuttle = time()

        func_LOF_Shuttle = LocalOutlierFactor(n_neighbors=n_neigh
ighbors, novelty=True)
        func_LOF_Shuttle.fit(X_Shuttle)
        y_pred_LOF_Shuttle = func_LOF_Shuttle.predict(X_Shuttl
e)

        # Calcul du temps d'exécution
        exec_time_LOF_Shuttle = time() - start_LOF_Shuttle
        executions_time_LOF_Shuttle.append(exec_time_LOF_Shutt
le)

        # Calcul de l'aire sous la courbe ROC
        auc_LOF_Shuttle = roc_auc_score(y_transform_Shuttle, y
_pred_LOF_Shuttle)
        roc_auc_LOF_Shuttle.append(auc_LOF_Shuttle)

    print("Execution time of LOF applied on Shuttle (in second
)")
    print(executions_time_LOF_Shuttle)
    print("ROC AUC for LOF applied on Shuttle")
    print(roc_auc_LOF_Shuttle)
    averages_executions_time_LOF_Shuttle.append(statistics.me
n(executions_time_LOF_Shuttle))
    averages_roc_auc_LOF_Shuttle.append(statistics.mean(roc_au
c_LOF_Shuttle))
```



```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[8.548911094665527, 7.140587091445923, 6.541306972503662, 6.311285018920898, 6.982913017272949]
```

ROC AUC for LOF applied on Shuttle

```
[0.5215160920903762, 0.5215160920903762, 0.5215160920903762, 0.5215160920903762, 0.5215160920903762]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[8.106007814407349, 10.845497131347656, 9.745582818984985, 8.954133987426758, 9.703468084335327]
```

ROC AUC for LOF applied on Shuttle

```
[0.5303294171661024, 0.5303294171661024, 0.5303294171661024, 0.5303294171661024, 0.5303294171661024]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[10.239574193954468, 10.467014074325562, 10.775267124176025, 10.272745132446289, 10.155516147613525]
```

ROC AUC for LOF applied on Shuttle

```
[0.5464129627777061, 0.5464129627777061, 0.5464129627777061, 0.5464129627777061, 0.5464129627777061]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[11.09737491607666, 11.359040021896362, 12.265018939971924, 11.640704870223999, 11.218759775161743]
```

ROC AUC for LOF applied on Shuttle

```
[0.5597715279848037, 0.5597715279848037, 0.5597715279848037, 0.5597715279848037, 0.5597715279848037]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[12.55742621421814, 11.96461796760559, 12.57378101348877, 13.2724769115448, 12.296541929244995]
```

ROC AUC for LOF applied on Shuttle

```
[0.5707113501557596, 0.5707113501557596, 0.5707113501557596, 0.5707113501557596, 0.5707113501557596]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[14.968611001968384, 15.172990322113037, 15.481447219848633, 12.923413276672363, 13.751121997833252]
```

ROC AUC for LOF applied on Shuttle

```
[0.5833266957335241, 0.5833266957335241, 0.5833266957335241, 0.5833266957335241, 0.5833266957335241]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[13.90953803062439, 13.948063850402832, 13.774773836135864, 14.092037916183472, 13.781497240066528]
```

ROC AUC for LOF applied on Shuttle

```
[0.6071569449398353, 0.6071569449398353, 0.6071569449398353, 0.6071569449398353, 0.6071569449398353]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[15.525487184524536, 15.68483567237854, 15.388175964355469, 15.29531216621399, 16.37880516052246]
```

ROC AUC for LOF applied on Shuttle

```
[0.6206598467119195, 0.6206598467119195, 0.6206598467119195, 0.6206598467119195, 0.6206598467119195]
```



```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[17.36264991760254, 25.102497816085815, 21.20089888572693, 16.928543090820312, 20.417612075805664]
```

ROC AUC for LOF applied on Shuttle

```
[0.6278985115819538, 0.6278985115819538, 0.6278985115819538, 0.6278985115819538, 0.6278985115819538]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[22.502599954605103, 19.250303030014038, 22.29130983352661, 23.096499919891357, 17.23454785346985]
```

ROC AUC for LOF applied on Shuttle

```
[0.6358931132894875, 0.6358931132894875, 0.6358931132894875, 0.6358931132894875, 0.6358931132894875]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[20.515130043029785, 18.800599813461304, 18.7432541847229, 20.603824853897095, 20.3718318939209]
```

ROC AUC for LOF applied on Shuttle

```
[0.6389370482705246, 0.6389370482705246, 0.6389370482705246, 0.6389370482705246, 0.6389370482705246]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[19.592599153518677, 20.091093063354492, 17.522411108016968, 17.463611841201782, 20.06765127182007]
```

ROC AUC for LOF applied on Shuttle

```
[0.6446098725311001, 0.6446098725311001, 0.6446098725311001, 0.6446098725311001, 0.6446098725311001]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[20.842701196670532, 24.88567304611206, 26.10126519203186, 23.518700122833252, 20.749629020690918]
```

ROC AUC for LOF applied on Shuttle

```
[0.6439855550504205, 0.6439855550504205, 0.6439855550504205, 0.6439855550504205, 0.6439855550504205]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[19.079163789749146, 19.068058013916016, 19.510679721832275, 20.462062120437622, 19.97934603691101]
```

ROC AUC for LOF applied on Shuttle

```
[0.6452341900117797, 0.6452341900117797, 0.6452341900117797, 0.6452341900117797, 0.6452341900117797]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[19.98332905769348, 20.267674922943115, 29.37620520591736, 25.0815589427948, 22.414516925811768]
```

ROC AUC for LOF applied on Shuttle

```
[0.6454746177017341, 0.6454746177017341, 0.6454746177017341, 0.6454746177017341, 0.6454746177017341]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[22.203749179840088, 22.69283699989319, 23.070982933044434, 22.550247192382812, 23.32349419593811]
```

ROC AUC for LOF applied on Shuttle

```
[0.6455513956598792, 0.6455513956598792, 0.6455513956598792, 0.6455513956598792, 0.6455513956598792]
```



```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[22.011680126190186, 21.317906141281128, 23.827029943466187, 28.214295148849487, 24.37269616127014]
```

ROC AUC for LOF applied on Shuttle

```
[0.6433274582663202, 0.6433274582663202, 0.6433274582663202, 0.6433274582663202, 0.6433274582663202]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[23.76908278465271, 23.217936992645264, 23.408956050872803, 23.79703998565674, 22.809025049209595]
```

ROC AUC for LOF applied on Shuttle

```
[0.6452223472678289, 0.6452223472678289, 0.6452223472678289, 0.6452223472678289, 0.6452223472678289]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[24.00037717819214, 23.512400150299072, 32.20188522338867, 25.832989931106567, 26.433369159698486]
```

ROC AUC for LOF applied on Shuttle

```
[0.6439846805862048, 0.6439846805862048, 0.6439846805862048, 0.6439846805862048, 0.6439846805862048]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[28.55326795578003, 23.9446861743927, 26.600772857666016, 24.454368114471436, 25.80253291130066]
```

ROC AUC for LOF applied on Shuttle

```
[0.6426153945477606, 0.6426153945477606, 0.6426153945477606, 0.6426153945477606, 0.6426153945477606]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[24.520621061325073, 25.380983114242554, 25.671968936920166, 26.67810082435608, 26.24145793914795]
```

ROC AUC for LOF applied on Shuttle

```
[0.6397022044593278, 0.6397022044593278, 0.6397022044593278, 0.6397022044593278, 0.6397022044593278]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[31.295750856399536, 27.675748109817505, 29.594388961791992, 28.73183512687683, 22.946579933166504]
```

ROC AUC for LOF applied on Shuttle

```
[0.6340622850379573, 0.6340622850379573, 0.6340622850379573, 0.6340622850379573, 0.6340622850379573]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[23.47481083869934, 23.13122034072876, 23.193423986434937, 822.1039469242096, 25.384517908096313]
```

ROC AUC for LOF applied on Shuttle

```
[0.6311600632292595, 0.6311600632292595, 0.6311600632292595, 0.6311600632292595, 0.6311600632292595]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[1755.7952139377594, 26.021297931671143, 36.12047481536865, 24.064188957214355, 24.732654094696045]
```

ROC AUC for LOF applied on Shuttle

```
[0.6276554604993521, 0.6276554604993521, 0.6276554604993521, 0.6276554604993521, 0.6276554604993521]
```



/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.

FutureWarning)

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.

FutureWarning)

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.

FutureWarning)

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.

FutureWarning)

/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

[29.610510110855103, 25.375948190689087, 26.24496293067932, 26.375334978103638, 32.57053589820862]

ROC AUC for LOF applied on Shuttle

[0.6256837935396983, 0.6256837935396983, 0.6256837935396983, 0.6256837935396983, 0.6256837935396983]

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[28.53094506263733, 27.911957025527954, 27.77123212814331, 26.486833333969116, 28.033424854278564]
```

ROC AUC for LOF applied on Shuttle

```
[0.6253665878915988, 0.6253665878915988, 0.6253665878915988, 0.6253665878915988, 0.6253665878915988]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[32.20329809188843, 33.18260097503662, 28.63064217567444, 28.9147789478302, 30.17589807510376]
```

ROC AUC for LOF applied on Shuttle

```
[0.6239314921747445, 0.6239314921747445, 0.6239314921747445, 0.6239314921747445, 0.6239314921747445]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[33.00988006591797, 31.16098117828369, 29.51857304573059, 29.466418981552124, 28.89672613143921]
```

ROC AUC for LOF applied on Shuttle

```
[0.6199341913209777, 0.6199341913209777, 0.6199341913209777, 0.6199341913209777, 0.6199341913209777]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[33.044429779052734, 29.72644305229187, 30.903799057006836, 29.281348943710327, 35.302117109298706]
```

ROC AUC for LOF applied on Shuttle

```
[0.6152138584689161, 0.6152138584689161, 0.6152138584689161, 0.6152138584689161, 0.6152138584689161]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[33.06908082962036, 34.36426019668579, 32.27237606048584, 31.718379020690918, 34.16162896156311]
```

ROC AUC for LOF applied on Shuttle

```
[0.6070766691248273, 0.6070766691248273, 0.6070766691248273, 0.6070766691248273, 0.6070766691248273]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[29.008259057998657, 28.686951875686646, 37.20945692062378, 34.627143144607544, 31.784306287765503]
```

ROC AUC for LOF applied on Shuttle

```
[0.600604034907812, 0.600604034907812, 0.600604034907812, 0.600604034907812, 0.600604034907812]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[30.09407091140747, 31.068660974502563, 31.05798602104187, 30.35109782218933, 30.627393007278442]
```

ROC AUC for LOF applied on Shuttle

```
[0.5925326552421332, 0.5925326552421332, 0.5925326552421332, 0.5925326552421332, 0.5925326552421332]
```



```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[30.898460865020752, 32.192503929138184, 31.596322774887085, 30.930474996566772, 32.383541107177734]
```

ROC AUC for LOF applied on Shuttle

```
[0.5804420381632174, 0.5804420381632174, 0.5804420381632174, 0.5804420381632174, 0.5804420381632174]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[31.535628080368042, 29.67800807952881, 31.008280038833618, 29.331932067871094, 29.513152837753296]
```

ROC AUC for LOF applied on Shuttle

```
[0.5716147216600389, 0.5716147216600389, 0.5716147216600389, 0.5716147216600389, 0.5716147216600389]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[31.129746198654175, 29.830172061920166, 31.112814903259277, 30.072266101837158, 29.939199209213257]
```

ROC AUC for LOF applied on Shuttle

```
[0.5646713258786342, 0.5646713258786342, 0.5646713258786342, 0.5646713258786342, 0.5646713258786342]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[31.273830890655518, 30.44507074356079, 37.11281681060791, 34.68531513214111, 31.82643485069275]
```

ROC AUC for LOF applied on Shuttle

```
[0.5561072480890957, 0.5561072480890957, 0.5561072480890957, 0.5561072480890957, 0.5561072480890957]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[33.049050092697144, 35.441572189331055, 43.89703392982483, 41.15648293495178, 41.83665609359741]
```

ROC AUC for LOF applied on Shuttle

```
[0.547893280786862, 0.547893280786862, 0.547893280786862, 0.547893280786862, 0.547893280786862]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[33.169673919677734, 34.13337707519531, 34.74171185493469, 33.59257698059082, 33.5199248790741]
```

ROC AUC for LOF applied on Shuttle

```
[0.5385403613206189, 0.5385403613206189, 0.5385403613206189, 0.5385403613206189, 0.5385403613206189]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied on Shuttle (in seconds)

```
[34.08888387680054, 32.08362698554993, 32.52544093132019, 35.860275745391846, 36.32122993469238]
```

ROC AUC for LOF applied on Shuttle

```
[0.5299433786918755, 0.5299433786918755, 0.5299433786918755, 0.5299433786918755, 0.5299433786918755]
```

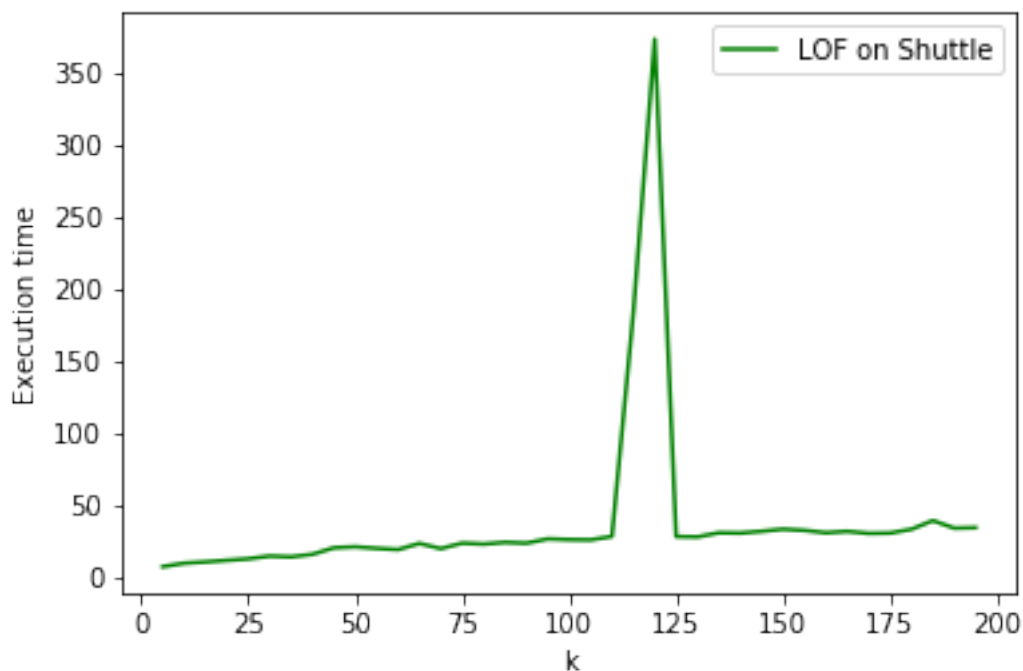
## Résultat de LOF sur shuttle

In [51]:

```
print("Execution time of LOF applied on Shuttle (in second)")
print(averages_executions_time_LOF_Shuttle)
plt.plot(range(5, 200, 5), averages_executions_time_LOF_Shuttle, "g-", label="LOF on Shuttle")
#plt.axis([0, 200, 0, 200])
plt.xlabel('k')
plt.ylabel('Execution time')
plt.legend(loc="best")
plt.show()
```

Execution time of LOF applied on Shuttle (in second)

```
[7.105000638961792, 9.470937967300415, 10.382023334503174, 11.516179704666138, 12.53296880722046, 14.459516763687134, 13.901182174682617, 15.654523229598999, 20.202440357208253, 20.87505211830139, 19.806928157806396, 18.947473287582397, 23.219593715667724, 19.619861936569215, 23.424657011032103, 22.768262100219726, 23.948721504211427, 23.40040817260742, 26.39620432853699, 25.871125602722167, 25.698626375198366, 28.048860597610474, 183.45758399963378, 373.3467659473419, 28.035458421707155, 27.746878480911256, 30.621443653106688, 30.410515880584718, 31.651627588272095, 33.11714501380921, 32.26322345733642, 30.639841747283935, 31.600260734558105, 30.213400220870973, 30.416839694976808, 33.06869368553161, 39.07615904808044, 33.83145294189453, 34.17589149475098]
```





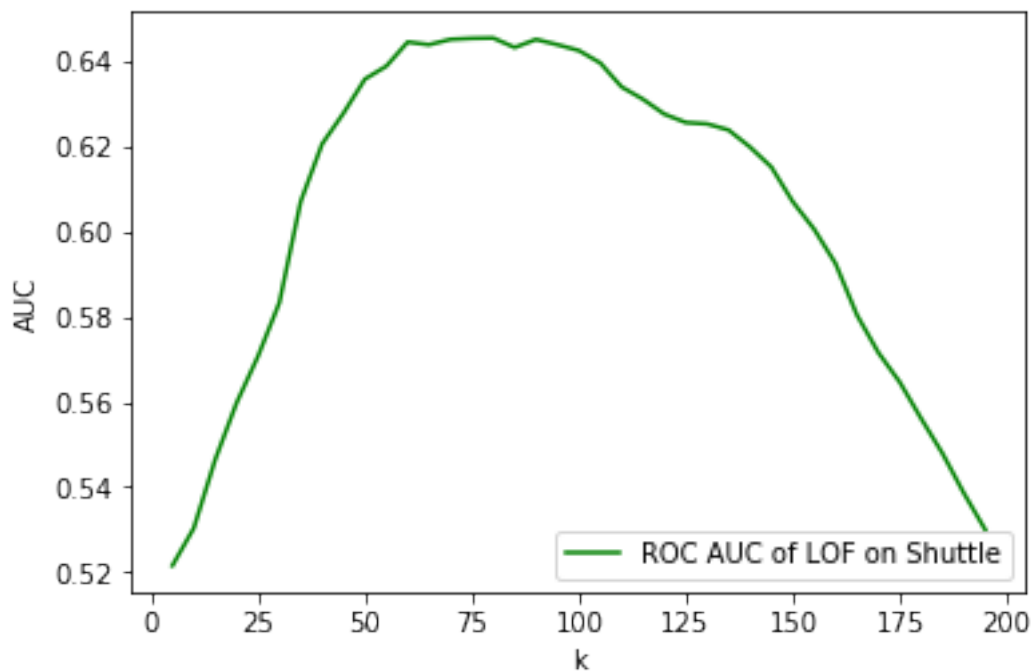
In [52]:

```
print("ROC AUC for LOF applied on Shuttle")
print(averages_roc_auc_LOF_Shuttle)
print("La valeur max est "+str(max(averages_roc_auc_LOF_Shuttle))+" à l'index "+str(averages_roc_auc_LOF_Shuttle.index(max(averages_roc_auc_LOF_Shuttle))))
plt.plot(range(5, 200, 5), averages_roc_auc_LOF_Shuttle, "g-", label="ROC AUC of LOF on Shuttle")
#plt.axis([0, 1, 0, 1])
plt.xlabel('k')
plt.ylabel('AUC')
plt.legend(loc="best")
plt.show()
```

ROC AUC for LOF applied on Shuttle

```
[0.5215160920903762, 0.5303294171661024, 0.5464129627777061, 0.5597715279848037, 0.5707113501557596, 0.5833266957335241, 0.6071569449398353, 0.6206598467119195, 0.6278985115819538, 0.6358931132894875, 0.6389370482705246, 0.6446098725311001, 0.6439855550504205, 0.6452341900117797, 0.6454746177017341, 0.6455513956598792, 0.6433274582663202, 0.6452223472678289, 0.6439846805862048, 0.6426153945477606, 0.6397022044593278, 0.6340622850379573, 0.6311600632292595, 0.6276554604993521, 0.6256837935396983, 0.6253665878915988, 0.6239314921747445, 0.6199341913209777, 0.6152138584689161, 0.6070766691248273, 0.600604034907812, 0.5925326552421332, 0.5804420381632174, 0.5716147216600389, 0.5646713258786342, 0.5561072480890957, 0.547893280786862, 0.5385403613206189, 0.5299433786918755]
```

La valeur max est 0.6455513956598792 à l'index 15



## Interprétation du résultat de LOF sur Shuttle

Plus le nombre de `n_neighbors` augmente, plus de temps d'exécution est important. Ceci s'explique par le fait que plus le nombre de voisins à considérer est grand plus il faudra calculer les distances et les densité afin d'estimer le degré d'aberrance d'une observation. Concernant la performance de la méthode, elle atteint son plus fort (AUC = 0.6455513956598792) à taux à `n_estimators= 80` ((15+1)\*5) pour un temps d'exécution de 22.768262100219726

In [5]:

```
averages_executions_time_LOF_Shuttle_fitPredict = []
averages_roc_auc_LOF_Shuttle_fitPredict = []

for j in range(5, 200, 5):
    n_neighbors = j
    executions_time_LOF_Shuttle_fitPredict = []
    roc_auc_LOF_Shuttle_fitPredict = []
    for i in range(5):
        start_LOF_Shuttle_fitPredict = time()

        func_LOF_Shuttle_fitPredict = LocalOutlierFactor(n_neighbors=n_neighbors)
        #func_LOF_Shuttle.fit(X_Shuttle)
        y_pred_LOF_Shuttle_fitPredict = func_LOF_Shuttle_fitPredict.fit_predict(X_Shuttle)

        # Calcul du temps d'exécution
        exec_time_LOF_Shuttle_fitPredict = time() - start_LOF_Shuttle_fitPredict
        executions_time_LOF_Shuttle_fitPredict.append(exec_time_LOF_Shuttle_fitPredict)

        # Calcul de l'aire sous la courbe ROC
        auc_LOF_Shuttle_fitPredict = roc_auc_score(y_transform_Shuttle, y_pred_LOF_Shuttle_fitPredict)
        roc_auc_LOF_Shuttle_fitPredict.append(auc_LOF_Shuttle_fitPredict)

    print("Execution time of LOF applied fitPredict on Shuttle (in second)")
    print(executions_time_LOF_Shuttle_fitPredict)
    print("ROC AUC for LOF applied fitPredict on Shuttle")
    print(roc_auc_LOF_Shuttle_fitPredict)
    averages_executions_time_LOF_Shuttle_fitPredict.append(statistics.mean(executions_time_LOF_Shuttle_fitPredict))
    averages_roc_auc_LOF_Shuttle_fitPredict.append(statistics.mean(roc_auc_LOF_Shuttle_fitPredict))
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)
```

```
[6.2639570236206055, 6.150643825531006, 6.120585918426514, 4.922743082046509, 4.789489030838013]
```

```
ROC AUC for LOF applied fitPredict on Shuttle
```

```
[0.5366775026940993, 0.5366775026940993, 0.5366775026940993, 0.5366775026940993, 0.5366775026940993]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
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```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)
```

```
[7.137811183929443, 7.112905979156494, 7.256501197814941, 6.4198267459869385, 7.721999883651733]
```

```
ROC AUC for LOF applied fitPredict on Shuttle
```

```
[0.5337752808854015, 0.5337752808854015, 0.5337752808854015, 0.5337752808854015, 0.5337752808854015]
```

```
/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)
```

```
/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)
```

```
/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)
```

```
/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)
```

```
/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)
```

```
Execution time of LOF applied fitPredict on Shuttl  
e (in second)
```

```
[8.534732818603516, 8.546464920043945, 10.30938792  
2286987, 11.044346809387207, 9.801023960113525]
```

```
ROC AUC for LOF applied fitPredict on Shuttle
```

```
[0.5494472786523698, 0.5494472786523698, 0.5494472  
786523698, 0.5494472786523698, 0.5494472786523698]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
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```

```
FutureWarning)
```

```
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```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
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```

```
FutureWarning)
```

Execution time of LOF applied fitPredict on Shuttle (in second)

```
[8.965462923049927, 8.604393243789673, 8.601096153259277, 8.615767240524292, 8.571898937225342]
```

ROC AUC for LOF applied fitPredict on Shuttle

```
[0.5627974989723796, 0.5627974989723796, 0.5627974989723796, 0.5627974989723796, 0.5627974989723796]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
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```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)
```

```
[9.43875002861023, 9.815952062606812, 9.423255920410156, 10.36380386352539, 9.737160921096802]
```

```
ROC AUC for LOF applied fitPredict on Shuttle
```

```
[0.5749868305689104, 0.5749868305689104, 0.5749868305689104, 0.5749868305689104, 0.5749868305689104]
```



```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
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```

```
FutureWarning)
```

```
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```

```
FutureWarning)
```

```
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```

```
FutureWarning)
```

```
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```

```
FutureWarning)
```

Execution time of LOF applied fitPredict on Shuttle (in second)

```
[10.14114260673523, 10.111436128616333, 10.113987922668457, 10.115614891052246, 12.810058116912842]
```

ROC AUC for LOF applied fitPredict on Shuttle

```
[0.5976241606767534, 0.5976241606767534, 0.5976241606767534, 0.5976241606767534, 0.5976241606767534]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
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```

```
FutureWarning)
```

```
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```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)
```

```
[12.409297227859497, 12.285495042800903, 12.210142850875854, 12.393171787261963, 13.459729194641113]
```

```
ROC AUC for LOF applied fitPredict on Shuttle
```

```
[0.6191006020611172, 0.6191006020611172, 0.6191006020611172, 0.6191006020611172, 0.6191006020611172]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
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```
FutureWarning)
```

```
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```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)

```
[11.617873191833496, 12.539975881576538, 17.015907049179077, 15.063608169555664, 13.771650075912476]
```

ROC AUC for LOF applied fitPredict on Shuttle

```
[0.6266463787637315, 0.6266463787637315, 0.6266463787637315, 0.6266463787637315, 0.6266463787637315]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)

```
[13.029826164245605, 14.426953077316284, 15.269773006439209, 17.185853004455566, 32.61293411254883]
```

ROC AUC for LOF applied fitPredict on Shuttle

```
[0.6336117111046062, 0.6336117111046062, 0.6336117111046062, 0.6336117111046062, 0.6336117111046062]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)

```
[17.34407091140747, 18.449026107788086, 16.8475079536438, 17.685969829559326, 17.03342628479004]
```

ROC AUC for LOF applied fitPredict on Shuttle

```
[0.64173793216896, 0.64173793216896, 0.64173793216896, 0.64173793216896, 0.64173793216896]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)
```

```
[16.666094064712524, 14.547420024871826, 14.102967023849487, 15.349633932113647, 16.54792809486389]
```

```
ROC AUC for LOF applied fitPredict on Shuttle
```

```
[0.6399965990837414, 0.6399965990837414, 0.6399965990837414, 0.6399965990837414, 0.6399965990837414]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)

```
[16.001083850860596, 13.953073978424072, 16.576987981796265, 18.04191780090332, 16.54656720161438]
```

ROC AUC for LOF applied fitPredict on Shuttle

```
[0.6452205983393975, 0.6452205983393975, 0.6452205983393975, 0.6452205983393975, 0.6452205983393975]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)
```

```
[17.493186712265015, 16.15676498413086, 14.66373872756958, 15.22176194190979, 16.296419858932495]
```

```
ROC AUC for LOF applied fitPredict on Shuttle
```

```
[0.6440597096159184, 0.6440597096159184, 0.6440597096159184, 0.6440597096159184, 0.6440597096159184]
```



```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)

```
[20.077375173568726, 18.318805932998657, 17.59625506401062, 15.317426919937134, 19.080501079559326]
```

ROC AUC for LOF applied fitPredict on Shuttle

```
[0.6446401539776578, 0.6446401539776578, 0.6446401539776578, 0.6446401539776578, 0.6446401539776578]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)

```
[20.372090101242065, 21.017306327819824, 23.05502200126648, 15.882473945617676, 17.12255597114563]
```

ROC AUC for LOF applied fitPredict on Shuttle

```
[0.645801042701137, 0.645801042701137, 0.645801042701137, 0.645801042701137, 0.645801042701137]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)

```
[16.230268955230713, 16.20698118209839, 16.284451246261597, 16.029670000076294, 18.455278158187866]
```

ROC AUC for LOF applied fitPredict on Shuttle

```
[0.645801042701137, 0.645801042701137, 0.645801042701137, 0.645801042701137, 0.645801042701137]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)
```

```
[23.928452968597412, 19.40214490890503, 19.75869917869568, 19.38458514213562, 18.383816957473755]
```

```
ROC AUC for LOF applied fitPredict on Shuttle
```

```
[0.6440597096159184, 0.6440597096159184, 0.6440597096159184, 0.6440597096159184, 0.6440597096159184]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)

```
[19.87593698501587, 17.64606499671936, 22.475360870361328, 17.239931106567383, 18.338455200195312]
```

ROC AUC for LOF applied fitPredict on Shuttle

```
[0.6463814870628766, 0.6463814870628766, 0.6463814870628766, 0.6463814870628766, 0.6463814870628766]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)
```

```
[17.168665885925293, 17.61018705368042, 28.16833996772766, 19.764774322509766, 17.88312792778015]
```

```
ROC AUC for LOF applied fitPredict on Shuttle
```

```
[0.6446401539776578, 0.6446401539776578, 0.6446401539776578, 0.6446401539776578, 0.6446401539776578]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)

```
[17.741116285324097, 19.410027980804443, 20.165122985839844, 20.86373209953308, 21.085635900497437]
```

ROC AUC for LOF applied fitPredict on Shuttle

```
[0.6423183765306997, 0.6423183765306997, 0.6423183765306997, 0.6423183765306997, 0.6423183765306997]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)

```
[21.67599606513977, 21.829285144805908, 21.26392889022827, 22.54395604133606, 19.845826864242554]
```

ROC AUC for LOF applied fitPredict on Shuttle

```
[0.6399965990837414, 0.6399965990837414, 0.6399965990837414, 0.6399965990837414, 0.6399965990837414]
```



```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)

```
[22.34662914276123, 22.37143611907959, 19.462400197982788, 22.24277663230896, 23.071624755859375]
```

ROC AUC for LOF applied fitPredict on Shuttle

```
[0.6359334885515644, 0.6359334885515644, 0.6359334885515644, 0.6359334885515644, 0.6359334885515644]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)

```
[22.46181321144104, 24.243808031082153, 19.922592878341675, 23.117843866348267, 18.674078941345215]
```

ROC AUC for LOF applied fitPredict on Shuttle

```
[0.6318703780193875, 0.6318703780193875, 0.6318703780193875, 0.6318703780193875, 0.6318703780193875]
```

```
/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)
```

```
/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)
```

```
/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)
```

```
/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)
```

```
/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)
```

Execution time of LOF applied fitPredict on Shuttle  
(in second)

```
[17.940247774124146, 17.783019065856934, 18.568716  
049194336, 43.48970007896423, 29.512925148010254]
```

ROC AUC for LOF applied fitPredict on Shuttle

```
[0.6301290449341688, 0.6301290449341688, 0.6301290  
449341688, 0.6301290449341688, 0.6301290449341688]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)
```

```
[23.75527286529541, 29.264535188674927, 22.92527174949646, 20.828255891799927, 20.228557109832764]
```

```
ROC AUC for LOF applied fitPredict on Shuttle
```

```
[0.6249050456785128, 0.6249050456785128, 0.6249050456785128, 0.6249050456785128, 0.6249050456785128]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)

```
[23.926175832748413, 21.136569261550903, 21.965434074401855, 20.79287075996399, 21.73565125465393]
```

ROC AUC for LOF applied fitPredict on Shuttle

```
[0.6249050456785128, 0.6249050456785128, 0.6249050456785128, 0.6249050456785128, 0.6249050456785128]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)
```

```
[27.17577290534973, 27.0945987701416, 23.23072624206543, 21.521471977233887, 20.648605823516846]
```

```
ROC AUC for LOF applied fitPredict on Shuttle
```

```
[0.6231637125932941, 0.6231637125932941, 0.6231637125932941, 0.6231637125932941, 0.6231637125932941]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)

```
[22.455617666244507, 24.267590045928955, 27.392186164855957, 22.2690691947937, 24.827516078948975]
```

ROC AUC for LOF applied fitPredict on Shuttle

```
[0.6202614907845962, 0.6202614907845962, 0.6202614907845962, 0.6202614907845962, 0.6202614907845962]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)
```

```
[23.63966989517212, 26.9871768951416, 25.582520961761475, 25.208393096923828, 22.831233024597168]
```

```
ROC AUC for LOF applied fitPredict on Shuttle
```

```
[0.6161983802524194, 0.6161983802524194, 0.6161983802524194, 0.6161983802524194, 0.6161983802524194]
```



```
/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)
```

```
/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)
```

```
/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)
```

```
/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)
```

```
/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)
```

Execution time of LOF applied fitPredict on Shuttle  
(in second)

```
[22.48629093170166, 29.966890811920166, 29.1540911  
19766235, 20.51272201538086, 20.675346851348877]
```

ROC AUC for LOF applied fitPredict on Shuttle

```
[0.6098134922732841, 0.6098134922732841, 0.6098134  
922732841, 0.6098134922732841, 0.6098134922732841]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)

```
[21.208412885665894, 1210.2186441421509, 34.20415210723877, 26.596996068954468, 26.911269903182983]
```

ROC AUC for LOF applied fitPredict on Shuttle

```
[0.6011068268471907, 0.6011068268471907, 0.6011068268471907, 0.6011068268471907, 0.6011068268471907]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)

```
[24.779940843582153, 24.96441102027893, 28.52423596382141, 28.283670902252197, 32.93068814277649]
```

ROC AUC for LOF applied fitPredict on Shuttle

```
[0.5918197170593578, 0.5918197170593578, 0.5918197170593578, 0.5918197170593578, 0.5918197170593578]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)

```
[29.16030192375183, 25.100205659866333, 30.966818809509277, 24.758387088775635, 27.08087396621704]
```

ROC AUC for LOF applied fitPredict on Shuttle

```
[0.5802108298245665, 0.5802108298245665, 0.5802108298245665, 0.5802108298245665, 0.5802108298245665]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)

```
[27.946221113204956, 30.536000967025757, 28.90926218032837, 27.16851282119751, 29.864578008651733]
```

ROC AUC for LOF applied fitPredict on Shuttle

```
[0.5709237200367335, 0.5709237200367335, 0.5709237200367335, 0.5709237200367335, 0.5709237200367335]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)
```

```
[31.439106702804565, 27.41464900970459, 29.959768056869507, 31.04922318458557, 22.40795397758484]
```

```
ROC AUC for LOF applied fitPredict on Shuttle
```

```
[0.5645388320575984, 0.5645388320575984, 0.5645388320575984, 0.5645388320575984, 0.5645388320575984]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)

```
[21.693238973617554, 21.83808994293213, 90.31403303146362, 186.81009221076965, 34.08453321456909]
```

ROC AUC for LOF applied fitPredict on Shuttle

```
[0.5558321666315049, 0.5558321666315049, 0.5558321666315049, 0.5558321666315049, 0.5558321666315049]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)
```

```
[22.89810299873352, 22.29163098335266, 25.9563570022583, 23.770857095718384, 28.354638814926147]
```

```
ROC AUC for LOF applied fitPredict on Shuttle
```

```
[0.5482863899288906, 0.5482863899288906, 0.5482863899288906, 0.5482863899288906, 0.5482863899288906]
```



```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)

```
[30.83831000328064, 27.566961765289307, 27.538749933242798, 24.748005867004395, 22.314210891723633]
```

ROC AUC for LOF applied fitPredict on Shuttle

```
[0.5378383914175784, 0.5378383914175784, 0.5378383914175784, 0.5378383914175784, 0.5378383914175784]
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

```
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: 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 LOF applied fitPredict on Shuttle (in second)
```

```
[28.9795138835907, 26.009949922561646, 25.384615898132324, 24.71794104576111, 24.891226768493652]
```

```
ROC AUC for LOF applied fitPredict on Shuttle
```

```
[0.5302926147149641, 0.5302926147149641, 0.5302926147149641, 0.5302926147149641, 0.5302926147149641]
```

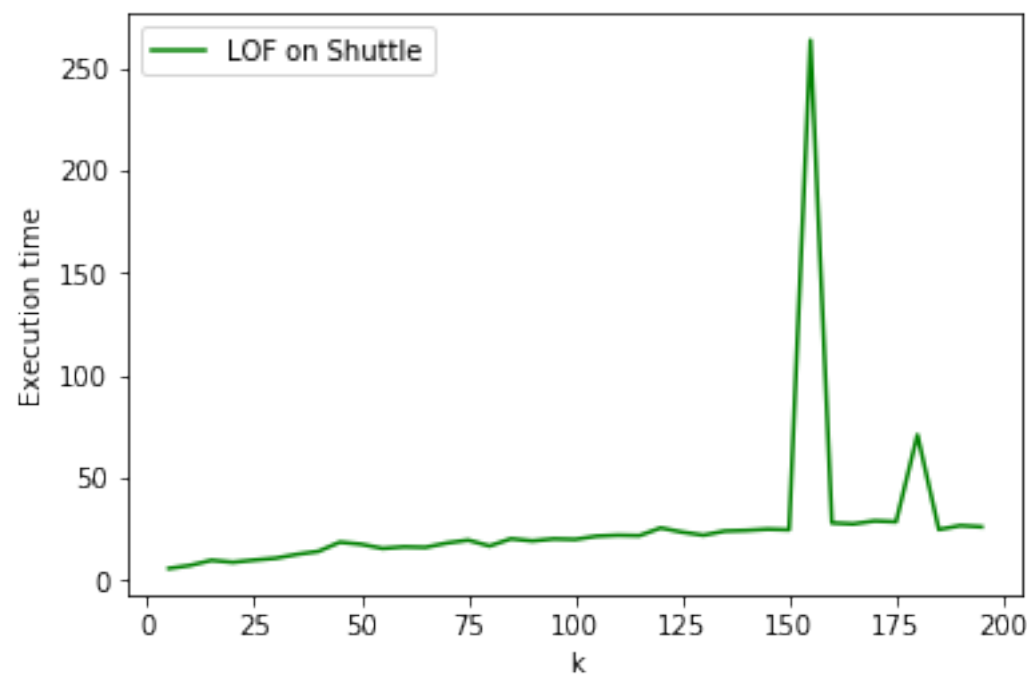
## Résultat de LOF sur shuttle

In [6]:

```
print("Execution time of LOF applied _fitPredict on Shuttle (i  
n second)")  
print(averages_executions_time_LOF_Shuttle_fitPredict)  
plt.plot(range(5, 200, 5), averages_executions_time_LOF_Shuttl  
e_fitPredict, "g-", label="LOF on Shuttle")  
#plt.axis([0, 200, 0, 200])  
plt.xlabel('k')  
plt.ylabel('Execution time')  
plt.legend(loc="best")  
plt.show()
```

Execution time of LOF applied \_fitPredict on Shuttle  
le (in second)

```
[5.649483776092529, 7.12980899810791, 9.647191286087036, 8.671723699569702, 9.755784559249879, 10.65844793319702, 12.551567220687867, 14.00180287361145, 18.5050678730011, 17.472000217437746, 15.442808628082275, 16.223926162719728, 15.966374444961549, 18.078072834014893, 19.489889669418336, 16.64132990837097, 20.1715398311615, 19.115149831771852, 20.119019031524658, 19.85312705039978, 21.43179860115051, 21.898973369598387, 21.68402738571167, 25.45892162322998, 23.4003785610199, 21.91134023666382, 23.9342351436615, 24.24239583015442, 24.84979877471924, 24.559068346023558, 263.8278950214386, 27.896589374542238, 27.413317489624024, 28.884915018081664, 28.454140186309814, 70.94799747467042, 24.654317378997803, 26.601247692108153, 25.996649503707886]
```



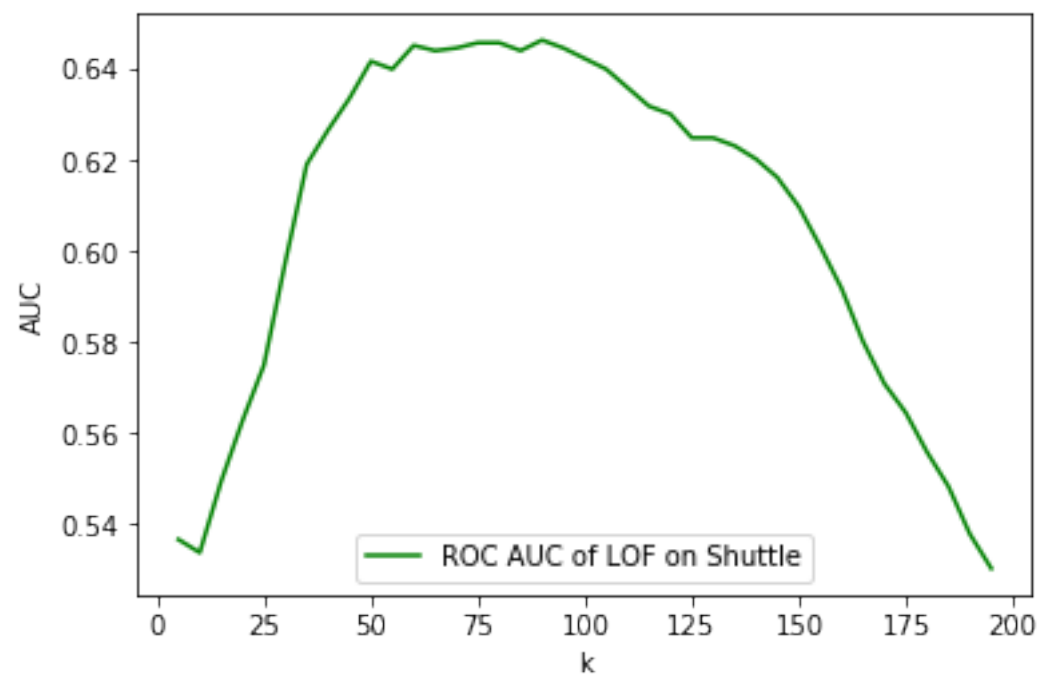
In [7]:

```
print("ROC AUC for LOF applied fitPredict on Shuttle")
print(averages_roc_auc_LOF_Shuttle_fitPredict)
print("La valeur max est "+str(max(averages_roc_auc_LOF_Shuttle_fitPredict))+
      " à l'index "+str(averages_roc_auc_LOF_Shuttle_fitPredict.index(
      max(averages_roc_auc_LOF_Shuttle_fitPredict))))
plt.plot(range(5, 200, 5), averages_roc_auc_LOF_Shuttle_fitPredict,
         "g-", label="ROC AUC of LOF on Shuttle")
#plt.axis([0, 1, 0, 1])
plt.xlabel('k')
plt.ylabel('AUC')
plt.legend(loc="best")
plt.show()
```

ROC AUC for LOF applied fitPredict on Shuttle

[0.5366775026940993, 0.5337752808854015, 0.5494472786523698, 0.5627974989723796, 0.5749868305689104, 0.5976241606767534, 0.6191006020611172, 0.6266463787637315, 0.6336117111046062, 0.64173793216896, 0.6399965990837414, 0.6452205983393975, 0.6440597096159184, 0.6446401539776578, 0.645801042701137, 0.645801042701137, 0.6440597096159184, 0.6463814870628766, 0.6446401539776578, 0.6423183765306997, 0.6399965990837414, 0.6359334885515644, 0.6318703780193875, 0.6301290449341688, 0.6249050456785128, 0.6249050456785128, 0.6231637125932941, 0.6202614907845962, 0.6161983802524194, 0.6098134922732841, 0.6011068268471907, 0.5918197170593578, 0.5802108298245665, 0.5709237200367335, 0.5645388320575984, 0.5558321666315049, 0.5482863899288906, 0.5378383914175784, 0.5302926147149641]

La valeur max est 0.6463814870628766 à l'index 17



## Interprétation du résultat de LOF sur Shuttle

Plus le nombre de `n_neighbors` augmente, plus de temps d'exécution est important. Ceci s'explique par le fait que plus le nombre de voisins à considérer est grand plus il faudra calculer les distances et les densité afin d'estimer le degré d'aberrance d'une observation. Concernant la performance de la méthode, elle atteint son plus fort ( $AUC = 0.6455513956598792$ ) à taux à `n_estimators= 80`  $((15+1)*5)$  pour un temps d'exécution de 22.768262100219726

# Exécution des méthodes avec les meilleurs paramètres trouvés sur Shuttle

In [10]:

```
executions_time_Shuttle = []
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_Shuttle)
# 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, max_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 = 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-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)

/Users/thesard/anaconda3/lib/python3.7/site-packages/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-packages/sklearn/ensemble/iforest.py:417: DeprecationWarning: threshold\_ attribute is deprecated in 0.20 and will be removed in 0.22.

" be removed in 0.22.", DeprecationWarning)

/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)

/Users/thesard/anaconda3/lib/python3.7/site-packages/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: DeprecationWarning: threshold_ attribute is deprecated in 0.20 and will be removed in 0.22.
```

```
    " be removed in 0.22.", DeprecationWarning)
/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)
/Users/thesard/anaconda3/lib/python3.7/site-packages/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-packages/sklearn/ensemble/iforest.py:417: DeprecationWarning: threshold_ attribute is deprecated in 0.20 and will be removed in 0.22.
```

```
    " be removed in 0.22.", DeprecationWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
```

```
    "avoid this warning.", FutureWarning)
/Users/thesard/anaconda3/lib/python3.7/site-packages/sklearn/neighbors/lof.py:236: FutureWarning: default contamination parameter 0.1 will change in version 0.22 to "auto". This will change the predict method behavior.
```

```
FutureWarning)
```

## Calcul des valeurs des métriques de comparaison

In [11]:

```
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_
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_estimators")
print(confusion_matrix(y_transform_Shuttle, y_pred_IF_Shuttle_estimators_samples))

# OC-SVM
# Precision
precisions_Shuttle.append(precision_score(y_transform_Shuttle, y_pred_OCSVM_Shuttle))
# Recall
recalls_Shuttle.append(recall_score(y_transform_Shuttle, y_pred_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_Shuttle))

# LOF
# Precision
precisions_Shuttle.append(precision_score(y_transform_Shuttle, y_pred_LOF_Shuttle))
# Recall
recalls_Shuttle.append(recall_score(y_transform_Shuttle, y_pred_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_LOF_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_estimators
[[ 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**

In [13]:

```
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 pourrions 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	0.9886105	0.9171017	3.8581349	

IForest max	0.9999043						
	0.9172333	0.95678638	0.9563387	0.9886105	0.9171017	5.2929310	

IForest n et max	0.9998804						
	0.9172114	0.95676349	0.9557583	0.9886105	0.9171017	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

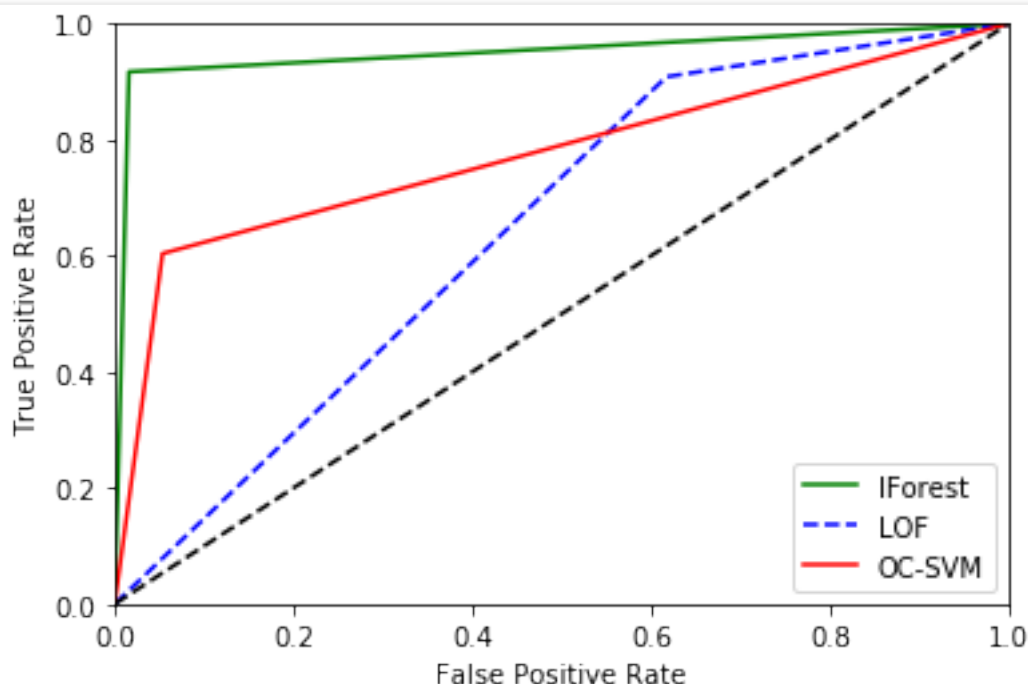
In [14]:

```
fpr_IF_Shuttle, tpr_IF_Shuttle, thresholds_IF_Shuttle = roc_curve(y_transform_Shuttle, y_pred_IF_Shuttle)
fpr_IF_Shuttle_max_samples, tpr_IF_Shuttle_max_samples, thresholds_IF_Shuttle_max_samples = roc_curve(y_transform_Shuttle, y_pred_IF_Shuttle_max_samples)
fpr_IF_Shuttle_estimators_samples, tpr_IF_Shuttle_estimators_samples, 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()
```

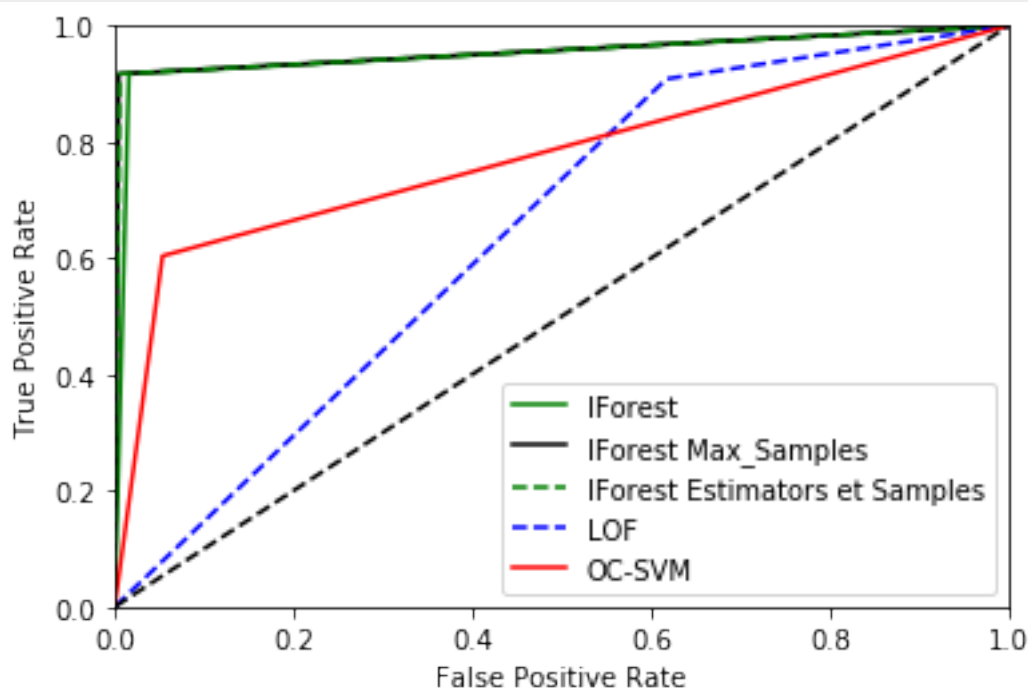


In [16]:

```
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 corrélation positive avec respectivement le nombre de voisins et nombre de d'estimateurs. Par contre, le temps d'exécution serait en corrélation négative avec nu.

In [ ]: