high_level_federated_image_classification

June 19, 2020

1 Federated learning: High level functionality

In this notebook we show the high-level functionality of the framework. It implements some predefined FL scenarios to make it as easy as possible to use. Clearly, in this predefined simulation there are some parameters prefixed (e.g. the aggregation operator or the learning model). If you prefer to set up your own simulation scenario, please see Basic Concepts Notebook where you will find more detailed information.

Specifically, we present the high-level funcion as follows:

HighLevelFunction(data_base_name, iid="True", num_nodes=20, percent=100)

where *data_base_name* may be one of the fixed datasets for each task.

The rest of the function params correspond to some changable params:

- *iid*: you can change between I.I.D (by default *iid="True"*) or non-I.I.D (*iid="False"*) data distributions. In both scenarios, data splitting between clients will be equitable (non weighted) and without replacement (for more information see Federated Sampling).
- *num_nodes*: you can choose the number of clients for the simulation by changing the *num_nodes* parameter (by default 20).
- *percent*: you decide the percentage of the database that you want to split across the clients by changing the *percent* parameter (by default 100, $percent \in [0, 100]$).

Furthermore, you have the possibility of changing the number of rounds of learning that you want to train changing the n param (by default 5) of the function:

run_rounds(n=5)

1.1 High-level image classifier

For the moment, the databases which can be used are:

- EMNIST: for the Emnist Digits dataset.
- FASHION_EMNIST: for the Fashion EMNIST database.

In addition, as FL model we use a CNN-based neural network architecture based on two CNN layers and FedAvg as aggregation operator (see Federated Aggregation Operators).

For more information about how to change some parameters or implementation details visit federated_images_classifier.py.

[1]:
```
import shfl

classifier = shfl.federated_government.FederatedImagesClassifier('EMNIST')
classifier.run_rounds()
```

```
Accuracy round 0
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345ab910>: [34.52666473388672, 0.822825014591217]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345aba10>: [60.64149856567383, 0.7330999970436096]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345abb50>: [47.118045806884766, 0.8064749836921692]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345abc90>: [43.41309356689453, 0.7978000044822693]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345abdd0>: [22.016021728515625, 0.8555999994277954]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9050>: [22.32573890686035, 0.8729249835014343]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b90d0>: [20.692516326904297, 0.8564749956130981]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9210>: [38.12157440185547, 0.8072749972343445]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9350>: [39.832054138183594, 0.7832499742507935]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b94d0>: [50.33693313598633, 0.7692000269889832]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9590>: [9.36400032043457, 0.9400249719619751]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b96d0>: [56.443519592285156, 0.824275016784668]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9810>: [30.71253776550293, 0.8339250087738037]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9950>: [29.39586639404297, 0.8156750202178955]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9a90>: [19.535070419311523, 0.8863000273704529]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9bd0>: [40.68940734863281, 0.8132249712944031]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9d10>: [22.264978408813477, 0.8547750115394592]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9e50>: [80.21239471435547, 0.700950026512146]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9f90>: [17.829811096191406, 0.8857750296592712]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345be110>: [30.376630783081055, 0.8326500058174133]
Global model test performance : [14.250382423400879, 0.8662499785423279]
```

```
Accuracy round 1
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345ab910>: [29.358436584472656, 0.8568249940872192]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345aba10>: [30.608375549316406, 0.8295249938964844]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345abb50>: [45.120479583740234, 0.8206999897956848]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345abc90>: [37.37858581542969, 0.8320000171661377]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345abdd0>: [20.990047454833984, 0.8889250159263611]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9050>: [18.02570152282715, 0.912024974822998]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b90d0>: [18.91881561279297, 0.8967750072479248]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9210>: [29.94452476501465, 0.8571000099182129]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9350>: [77.09952545166016, 0.7475000023841858]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b94d0>: [46.227420806884766, 0.8254250288009644]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9590>: [28.671733856201172, 0.8557249903678894]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b96d0>: [42.70770263671875, 0.8498250246047974]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9810>: [41.871612548828125, 0.8387500047683716]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9950>: [19.728126525878906, 0.9033750295639038]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9a90>: [19.000782012939453, 0.8952999711036682]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9bd0>: [34.096954345703125, 0.8466500043869019]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9d10>: [30.56700325012207, 0.855774998664856]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9e50>: [32.444984436035156, 0.8302249908447266]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9f90>: [18.326095581054688, 0.8983749747276306]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345be110>: [40.49760055541992, 0.843999981880188]
Global model test performance : [20.0017147064209, 0.8951500058174133]
```

```
Accuracy round 2
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345ab910>: [32.3129997253418, 0.8616499900817871]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345aba10>: [27.845163345336914, 0.8550249934196472]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345abb50>: [56.098812103271484, 0.8305000066757202]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345abc90>: [29.144731521606445, 0.8811749815940857]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345abdd0>: [50.55776596069336, 0.830299973487854]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9050>: [32.00564193725586, 0.8762000203132629]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b90d0>: [21.2204532623291, 0.9057999849319458]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9210>: [16.132905960083008, 0.9235000014305115]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9350>: [53.72598648071289, 0.8004000186920166]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b94d0>: [21.435789108276367, 0.9045249819755554]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9590>: [10.68554401397705, 0.9449750185012817]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b96d0>: [12.261937141418457, 0.9442499876022339]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9810>: [25.381378173828125, 0.8928250074386597]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9950>: [13.491100311279297, 0.940500020980835]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9a90>: [24.61970329284668, 0.8834249973297119]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9bd0>: [34.33242416381836, 0.8589249849319458]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9d10>: [25.524099349975586, 0.8931000232696533]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9e50>: [35.123966217041016, 0.8453999757766724]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9f90>: [15.126977920532227, 0.9339249730110168]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345be110>: [16.57851219177246, 0.9258750081062317]
Global model test performance : [16.60980987548828, 0.9222999811172485]



Accuracy round 3
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345ab910>: [52.52549362182617, 0.8367999792098999]
```

```
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345aba10>: [21.96200942993164, 0.9038500189781189]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345abb50>: [48.01543426513672, 0.8553500175476074]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345abc90>: [23.034988403320312, 0.894225001335144]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345abdd0>: [25.083478927612305, 0.894349992275238]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9050>: [34.664894104003906, 0.885325014591217]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b90d0>: [52.52248001098633, 0.8363500237464905]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9210>: [16.348421096801758, 0.9246749877929688]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9350>: [95.38256072998047, 0.7590000033378601]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b94d0>: [20.221529006958008, 0.9185749888420105]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9590>: [25.307235717773438, 0.8928999900817871]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b96d0>: [21.610191345214844, 0.9127749800682068]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9810>: [23.71278190612793, 0.8987249732017517]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9950>: [19.792076110839844, 0.9206249713897705]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9a90>: [26.358238220214844, 0.8965499997138977]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9bd0>: [24.957828521728516, 0.9013500213623047]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9d10>: [16.80759048461914, 0.9288750290870667]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9e50>: [55.6602668762207, 0.7961750030517578]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9f90>: [17.535566329956055, 0.9275000095367432]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345be110>: [27.018997192382812, 0.8977000117301941]
Global model test performance : [20.002321243286133, 0.9146249890327454]



Accuracy round 4
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345ab910>: [30.12713050842285, 0.8900750279426575]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345aba10>: [49.59697341918945, 0.833175003528595]
Test performance client <shfl.private.federated_operation.FederatedDataNode
```

```
object at 0x1345abb50>: [25.07254409790039, 0.9092000126838684]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345abc90>: [27.942424774169922, 0.8964499831199646]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345abdd0>: [47.06834411621094, 0.8478249907493591]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9050>: [22.78983497619629, 0.9203000068664551]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b90d0>: [47.057106018066406, 0.8468000292778015]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9210>: [14.231680870056152, 0.9354000091552734]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9350>: [34.07517623901367, 0.8715749979019165]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b94d0>: [37.02938461303711, 0.8777250051498413]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9590>: [13.067156791687012, 0.9439250230789185]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b96d0>: [17.224985122680664, 0.9340999722480774]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9810>: [29.2380313873291, 0.892549991607666]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9950>: [14.002612113952637, 0.9455249905586243]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9a90>: [36.56325912475586, 0.8762500286102295]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9bd0>: [39.012298583984375, 0.8643749952316284]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9d10>: [44.47160339355469, 0.8356000185012817]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9e50>: [65.06144714355469, 0.7907999753952026]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345b9f90>: [19.18354034423828, 0.9276999831199646]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1345be110>: [35.22935104370117, 0.8805750012397766]
Global model test performance : [19.316450119018555, 0.9224749803543091]
```

1.2 High-level clustering

For the moment, the databases which can be used are:

- IRIS: for the Iris dataset.

In addition, as FL model we use KMeans from scikit-learn with the same number of clustering in each client and ClusterFedAvg as aggregation operator (see Federated Aggregation Operators).

For more information about how to change some parameters or implementation details visit federated_clustering.py.

[2]:
```
clustering = shfl.federated_government.FederatedClustering('IRIS')
clustering.run_rounds()
```

```
Accuracy round 0
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052be910>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052ccd10>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052cc790>: (0.6201794406677201, 1.0000000000000002,
0.7655688315759979, 0.6145374449339207)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138477990>: (0.7427244708091654, 0.813451103303128,
0.7764805594954681, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13707da10>: (0.6550892108258862, 0.6550892108258862,
0.6550892108258862, 0.5880557977332171)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138952890>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138952cd0>: (0.6201794406677201, 1.0000000000000002,
0.7655688315759979, 0.6145374449339207)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138952690>: (0.708108947489923, 0.708108947489923,
0.708108947489923, 0.6795989537925022)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc76d0>: (0.8462932564414634, 0.8462932564414634,
0.8462932564414634, 0.8169136878814298)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7710>: (0.7427244708091654, 0.813451103303128,
0.7764805594954681, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7e90>: (0.6201794406677201, 1.0000000000000002,
0.7655688315759979, 0.6145374449339207)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7450>: (0.7427244708091654, 0.813451103303128,
0.7764805594954681, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7690>: (0.2425000795828176, 0.45378761925387484,
0.31608639350261347, 0.2140183735964614)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7310>: (0.7427244708091655, 0.8134511033031281,
```

```
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7a50>: (0.627196875226518, 0.6451928095981281,
0.6360675804352064, 0.5507060333761232)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7150>: (0.3447939449710147, 0.5415455780097195,
0.4213320773412881, 0.37336814621409925)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7290>: (0.6748641454569813, 0.830041729736677,
0.74445240976987, 0.6297021943573669)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7110>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7dd0>: (0.6201794406677201, 1.0000000000000002,
0.7655688315759979, 0.6145374449339207)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7490>: (0.6201794406677201, 1.0000000000000002,
0.7655688315759979, 0.6145374449339207)
Global model test performance : (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)



Accuracy round 1
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052be910>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052ccd10>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
```

```
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
```

```
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
```

```
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)

Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052cc790>: (0.6201794406677201, 1.0000000000000002,
0.7655688315759979, 0.6145374449339207)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138477990>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13707da10>: (0.6550892108258862, 0.6550892108258862,
0.6550892108258862, 0.5880557977332171)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138952890>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138952cd0>: (0.6201794406677201, 1.0000000000000002,
0.7655688315759979, 0.6145374449339207)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138952690>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc76d0>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7710>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7e90>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7450>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
```

```
object at 0x138cc7690>: (0.2425000795828176, 0.45378761925387484,
0.31608639350261347, 0.2140183735964614)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7310>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7a50>: (0.6271968752265181, 0.6451928095981282,
0.6360675804352065, 0.5507060333761232)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7150>: (0.6201794406677201, 1.0000000000000002,
0.7655688315759979, 0.6145374449339207)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7290>: (0.6748641454569813, 0.830041729736677,
0.74445240976987, 0.6297021943573669)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7110>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7dd0>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7490>: (0.6201794406677201, 1.0000000000000002,
0.7655688315759979, 0.6145374449339207)
Global model test performance : (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)



Accuracy round 2
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052be910>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052ccd10>: (0.7081089474899229, 0.7081089474899229,
0.7081089474899229, 0.6795989537925022)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052cc790>: (0.6201794406677201, 1.0000000000000002,
0.7655688315759979, 0.6145374449339207)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138477990>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13707da10>: (0.6550892108258862, 0.6550892108258862,
0.6550892108258862, 0.5880557977332171)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138952890>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
```

```
object at 0x138952cd0>: (0.6201794406677201, 1.0000000000000002,
0.7655688315759979, 0.6145374449339207)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138952690>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc76d0>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7710>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7e90>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7450>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7690>: (0.2425000795828176, 0.45378761925387484,
0.31608639350261347, 0.2140183735964614)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7310>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
```

```
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
```

```
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
```

```
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
```

```
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7a50>: (0.627196875226518, 0.6451928095981281,
0.6360675804352064, 0.5507060333761232)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7150>: (0.6201794406677201, 1.0000000000000002,
0.7655688315759979, 0.6145374449339207)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7290>: (0.6748641454569813, 0.830041729736677,
0.74445240976987, 0.6297021943573669)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7110>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7dd0>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7490>: (0.6201794406677201, 1.0000000000000002,
0.7655688315759979, 0.6145374449339207)
Global model test performance : (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
```

```
Accuracy round 3
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052be910>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052ccd10>: (0.708108947489923, 0.708108947489923,
0.708108947489923, 0.6795989537925022)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052cc790>: (0.6201794406677201, 1.0000000000000002,
0.7655688315759979, 0.6145374449339207)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138477990>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13707da10>: (0.6550892108258862, 0.6550892108258862,
0.6550892108258862, 0.5880557977332171)
```

```
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
```

```
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)

Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138952890>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138952cd0>: (0.6201794406677201, 1.0000000000000002,
0.7655688315759979, 0.6145374449339207)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138952690>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc76d0>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7710>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
```

```
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7e90>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7450>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7690>: (0.2425000795828176, 0.45378761925387484,
0.31608639350261347, 0.2140183735964614)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7310>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7a50>: (0.627196875226518, 0.6451928095981281,
0.6360675804352064, 0.5507060333761232)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7150>: (0.6201794406677201, 1.0000000000000002,
0.7655688315759979, 0.6145374449339207)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7290>: (0.6748641454569813, 0.830041729736677,
0.74445240976987, 0.6297021943573669)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7110>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7dd0>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7490>: (0.6201794406677201, 1.0000000000000002,
0.7655688315759979, 0.6145374449339207)
Global model test performance : (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
```

```
Accuracy round 4
```

```
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
```

```
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
```

```
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)
/usr/local/lib/python3.7/site-packages/shfl/model/kmeans_model.py:38:
RuntimeWarning: Explicit initial center position passed: performing only one
init in k-means instead of n_init=10
  self._k_means.fit(data)

Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052be910>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052ccd10>: (0.708108947489923, 0.708108947489923,
0.708108947489923, 0.6795989537925022)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052cc790>: (0.6201794406677201, 1.0000000000000002,
0.7655688315759979, 0.6145374449339207)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138477990>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13707da10>: (0.6550892108258862, 0.6550892108258862,
0.6550892108258862, 0.5880557977332171)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138952890>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138952cd0>: (0.6201794406677201, 1.0000000000000002,
0.7655688315759979, 0.6145374449339207)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138952690>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc76d0>: (0.7427244708091655, 0.8134511033031281,
```

```
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7710>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7e90>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7450>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7690>: (0.2425000795828176, 0.45378761925387484,
0.31608639350261347, 0.2140183735964614)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7310>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7a50>: (0.627196875226518, 0.6451928095981281,
0.6360675804352064, 0.5507060333761232)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7150>: (0.6201794406677201, 1.0000000000000002,
0.7655688315759979, 0.6145374449339207)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7290>: (0.6748641454569813, 0.830041729736677,
0.74445240976987, 0.6297021943573669)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7110>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7dd0>: (0.7427244708091655, 0.8134511033031281,
0.7764805594954682, 0.6966570367313248)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138cc7490>: (0.6201794406677201, 1.0000000000000002,
0.7655688315759979, 0.6145374449339207)
Global model test performance : (0.7427244708091654, 0.813451103303128,
0.7764805594954681, 0.6966570367313248)
```

1.3 High-level linear regression

For the moment, the databases which can be used are:

- CALIFORNIA: for the California Housing dataset.

In addition, as FL model we use LinearRegression from scikit-learn with the same number of clustering in each client and FedAvg as aggregation operator (see Federated Aggregation Operators).

For more information about how to change some parameters or implementation details visit federated_linear_regression.py.

[3]:
```
linear_regression = shfl.federated_government.
 ↪FederatedLinearRegression('CALIFORNIA')
linear_regression.run_rounds()
```

```
Accuracy round 0
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138a6cdd0>: (0.8633646899412738, 0.4654438759181613)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1357e1dd0>: (0.7712584929581213, 0.5734159014110873)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13833a7d0>: (0.7419645264298311, 0.6052055600131838)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13833a690>: (0.947305580527632, 0.35644608721218707)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13833a250>: (0.786698157202289, 0.5561655492756263)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138a9b790>: (0.7433288770491443, 0.6037523011232152)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138a9b4d0>: (0.8506639734267935, 0.48105560644972634)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138a9b990>: (0.8713430019628563, 0.4555186119723349)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138126450>: (0.8858388054602154, 0.4372517589198245)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1357d4650>: (0.7582801769540072, 0.5876517562024289)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13580f390>: (0.7390433788480528, 0.6083080873676602)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052d3b90>: (0.766022144941057, 0.5791886999791729)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13707d5d0>: (0.7369956955503483, 0.6104756187102043)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052be7d0>: (0.7465565570380787, 0.6003036593245836)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052bed90>: (0.7520958312667272, 0.5943503490210152)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052be650>: (0.8999158517730351, 0.4192241522252773)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052bec10>: (0.7644963752612655, 0.5808633818280249)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052cca50>: (0.7351658773565247, 0.6124074454027947)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138126850>: (0.7462183919064085, 0.6006656754428761)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138126bd0>: (0.7639082312308619, 0.5815080359664341)
```

```
Global model test performance : (0.759580936395887, 0.5862358523432076)



Accuracy round 1
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138a6cdd0>: (0.8633646899412738, 0.4654438759181613)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1357e1dd0>: (0.7712584929581213, 0.5734159014110873)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13833a7d0>: (0.7419645264298311, 0.6052055600131838)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13833a690>: (0.947305580527632, 0.35644608721218707)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13833a250>: (0.786698157202289, 0.5561655492756263)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138a9b790>: (0.7433288770491443, 0.6037523011232152)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138a9b4d0>: (0.8506639734267935, 0.48105560644972634)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138a9b990>: (0.8713430019628563, 0.4555186119723349)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138126450>: (0.8858388054602154, 0.4372517589198245)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1357d4650>: (0.7582801769540072, 0.5876517562024289)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13580f390>: (0.7390433788480528, 0.6083080873676602)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052d3b90>: (0.766022144941057, 0.5791886999791729)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13707d5d0>: (0.7369956955503483, 0.6104756187102043)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052be7d0>: (0.7465565570380787, 0.6003036593245836)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052bed90>: (0.7520958312667272, 0.5943503490210152)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052be650>: (0.8999158517730351, 0.4192241522252773)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052bec10>: (0.7644963752612655, 0.5808633818280249)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052cca50>: (0.7351658773565247, 0.6124074454027947)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138126850>: (0.7462183919064085, 0.6006656754428761)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138126bd0>: (0.7639082312308619, 0.5815080359664341)
Global model test performance : (0.759580936395887, 0.5862358523432076)
```

```
Accuracy round 2
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138a6cdd0>: (0.8633646899412738, 0.4654438759181613)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1357e1dd0>: (0.7712584929581213, 0.5734159014110873)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13833a7d0>: (0.7419645264298311, 0.6052055600131838)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13833a690>: (0.947305580527632, 0.35644608721218707)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13833a250>: (0.786698157202289, 0.5561655492756263)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138a9b790>: (0.7433288770491443, 0.6037523011232152)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138a9b4d0>: (0.8506639734267935, 0.48105560644972634)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138a9b990>: (0.8713430019628563, 0.4555186119723349)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138126450>: (0.8858388054602154, 0.4372517589198245)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1357d4650>: (0.7582801769540072, 0.5876517562024289)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13580f390>: (0.7390433788480528, 0.6083080873676602)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052d3b90>: (0.766022144941057, 0.5791886999791729)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13707d5d0>: (0.7369956955503483, 0.6104756187102043)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052be7d0>: (0.7465565570380787, 0.6003036593245836)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052bed90>: (0.7520958312667272, 0.5943503490210152)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052be650>: (0.8999158517730351, 0.4192241522252773)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052bec10>: (0.7644963752612655, 0.5808633818280249)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052cca50>: (0.7351658773565247, 0.6124074454027947)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138126850>: (0.7462183919064085, 0.6006656754428761)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138126bd0>: (0.7639082312308619, 0.5815080359664341)
Global model test performance : (0.759580936395887, 0.5862358523432076)



Accuracy round 3
Test performance client <shfl.private.federated_operation.FederatedDataNode
```

```
object at 0x138a6cdd0>: (0.8633646899412738, 0.4654438759181613)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1357e1dd0>: (0.7712584929581213, 0.5734159014110873)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13833a7d0>: (0.7419645264298311, 0.6052055600131838)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13833a690>: (0.947305580527632, 0.35644608721218707)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13833a250>: (0.786698157202289, 0.5561655492756263)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138a9b790>: (0.7433288770491443, 0.6037523011232152)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138a9b4d0>: (0.8506639734267935, 0.48105560644972634)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138a9b990>: (0.8713430019628563, 0.4555186119723349)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138126450>: (0.8858388054602154, 0.4372517589198245)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1357d4650>: (0.7582801769540072, 0.5876517562024289)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13580f390>: (0.7390433788480528, 0.6083080873676602)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052d3b90>: (0.766022144941057, 0.5791886999791729)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13707d5d0>: (0.7369956955503483, 0.6104756187102043)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052be7d0>: (0.7465565570380787, 0.6003036593245836)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052bed90>: (0.7520958312667272, 0.5943503490210152)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052be650>: (0.8999158517730351, 0.4192241522252773)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052bec10>: (0.7644963752612655, 0.5808633818280249)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052cca50>: (0.7351658773565247, 0.6124074454027947)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138126850>: (0.7462183919064085, 0.6006656754428761)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138126bd0>: (0.7639082312308619, 0.5815080359664341)
Global model test performance : (0.759580936395887, 0.5862358523432076)



Accuracy round 4
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138a6cdd0>: (0.8633646899412738, 0.4654438759181613)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1357e1dd0>: (0.7712584929581213, 0.5734159014110873)
```

```
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13833a7d0>: (0.7419645264298311, 0.6052055600131838)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13833a690>: (0.947305580527632, 0.35644608721218707)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13833a250>: (0.786698157202289, 0.5561655492756263)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138a9b790>: (0.7433288770491443, 0.6037523011232152)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138a9b4d0>: (0.8506639734267935, 0.48105560644972634)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138a9b990>: (0.8713430019628563, 0.4555186119723349)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138126450>: (0.8858388054602154, 0.4372517589198245)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1357d4650>: (0.7582801769540072, 0.5876517562024289)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13580f390>: (0.7390433788480528, 0.6083080873676602)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052d3b90>: (0.766022144941057, 0.5791886999791729)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13707d5d0>: (0.7369956955503483, 0.6104756187102043)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052be7d0>: (0.7465565570380787, 0.6003036593245836)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052bed90>: (0.7520958312667272, 0.5943503490210152)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052be650>: (0.8999158517730351, 0.4192241522252773)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052bec10>: (0.7644963752612655, 0.5808633818280249)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1052cca50>: (0.7351658773565247, 0.6124074454027947)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138126850>: (0.7462183919064085, 0.6006656754428761)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x138126bd0>: (0.7639082312308619, 0.5815080359664341)
Global model test performance : (0.759580936395887, 0.5862358523432076)
```