

# high\_level\_federated\_image\_classification

June 18, 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 function 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 0x10b24ced0>: [37.27372360229492, 0.8061500191688538]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dfef450>: [29.744821548461914, 0.8475499749183655]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dfef610>: [10.903645515441895, 0.9358999729156494]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dfef750>: [13.411766052246094, 0.918025016784668]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dfef890>: [10.31839656829834, 0.9283999800682068]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dfefad0>: [23.631330490112305, 0.8876500129699707]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dfefbb50>: [11.370607376098633, 0.9266499876976013]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dfefbc90>: [25.729013442993164, 0.8467749953269958]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dfefbdd0>: [22.279529571533203, 0.8664000034332275]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dfefbf50>: [17.481882095336914, 0.8995749950408936]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dff9050>: [19.478355407714844, 0.8893499970436096]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dff9190>: [31.43024444580078, 0.8344749808311462]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dff92d0>: [9.079512596130371, 0.9391499757766724]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dff9410>: [15.982823371887207, 0.9083250164985657]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dff9550>: [16.101367950439453, 0.9025999903678894]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dff9690>: [19.20415496826172, 0.8804000020027161]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dff97d0>: [11.929902076721191, 0.924049973487854]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dff9910>: [14.079462051391602, 0.9172750115394592]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dff9a50>: [25.059083938598633, 0.8460749983787537]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dff9b90>: [16.06496810913086, 0.9059000015258789]

Global model test performance : [6.763729095458984, 0.936424970626831]

Accuracy round 1

Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x10b24ced0>: [12.637468338012695, 0.9361749887466431]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a3dfef450>: [18.620744705200195, 0.897849977016449]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a3dfef610>: [11.592885971069336, 0.941100001335144]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a3dfef750>: [10.60046672821045, 0.9455000162124634]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a3dfef890>: [8.377948760986328, 0.9490000009536743]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a3dfefad0>: [23.750728607177734, 0.9033250212669373]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a3dfefbb50>: [13.409390449523926, 0.9297249913215637]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a3dfefbc90>: [15.709320068359375, 0.9139000177383423]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a3dfefbdd0>: [76.30965423583984, 0.7390000224113464]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a3dfefbf50>: [13.38101863861084, 0.9259499907493591]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a3dff9050>: [14.917342185974121, 0.9256749749183655]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a3dff9190>: [28.82879066467285, 0.8551250100135803]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a3dff92d0>: [10.657660484313965, 0.9469000101089478]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a3dff9410>: [9.095564842224121, 0.9534749984741211]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a3dff9550>: [16.460777282714844, 0.9199749827384949]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a3dff9690>: [31.48836326599121, 0.8574249744415283]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a3dff97d0>: [7.958975791931152, 0.9567999839782715]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a3dff9910>: [16.416780471801758, 0.9236249923706055]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a3dff9a50>: [14.405923843383789, 0.9277750253677368]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a3dff9b90>: [14.675827980041504, 0.9302999973297119]  
Global model test performance : [9.43567180633545, 0.9507499933242798]

#### Accuracy round 2

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x10b24ced0>: [27.149837493896484, 0.8876749873161316]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dfef450>: [13.06945514678955, 0.9400500059127808]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dfef610>: [11.056787490844727, 0.9519500136375427]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dfef750>: [12.103025436401367, 0.9392499923706055]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dfef890>: [10.532896041870117, 0.9453499913215637]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dfefbad0>: [11.107831954956055, 0.9536749720573425]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dfefbb50>: [13.571575164794922, 0.9406999945640564]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dfefbc90>: [18.727258682250977, 0.9094750285148621]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dfefbdd0>: [75.60685729980469, 0.7612749934196472]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dfefbf50>: [14.46103572845459, 0.9347749948501587]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dff9050>: [17.017549514770508, 0.9224249720573425]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dff9190>: [38.24906921386719, 0.8493499755859375]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dff92d0>: [10.540715217590332, 0.9492250084877014]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dff9410>: [14.12404727935791, 0.9426500201225281]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dff9550>: [15.94626522064209, 0.9328749775886536]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dff9690>: [16.19135284423828, 0.9221500158309937]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dff97d0>: [11.21247386932373, 0.9455999732017517]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dff9910>: [12.092879295349121, 0.9417499899864197]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dff9a50>: [17.36882209777832, 0.921999990940094]  
Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dff9b90>: [17.356050491333008, 0.9261000156402588]  
Global model test performance : [9.918529510498047, 0.9535250067710876]

#### Accuracy round 3

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x10b24ced0>: [26.050405502319336, 0.8967999815940857]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dfef450>: [19.72357177734375, 0.9205250144004822]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dfef610>: [19.639968872070312, 0.9207749962806702]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dfef750>: [18.759458541870117, 0.918150007724762]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dfef890>: [12.575891494750977, 0.9456750154495239]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dfefbad0>: [16.682682037353516, 0.9418500065803528]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dfefbb50>: [20.660587310791016, 0.9126250147819519]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dfefbc90>: [39.952903747558594, 0.8593000173568726]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dfefbdd0>: [49.182472229003906, 0.8346499800682068]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dfefbf50>: [7.024550914764404, 0.9666249752044678]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dff9050>: [25.570077896118164, 0.9004999995231628]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dff9190>: [25.188953399658203, 0.9017249941825867]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dff92d0>: [24.18166160583496, 0.8949750065803528]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dff9410>: [20.336326599121094, 0.9221500158309937]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dff9550>: [22.52389144897461, 0.9159500002861023]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dff9690>: [21.21814727783203, 0.9180999994277954]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dff97d0>: [16.670276641845703, 0.9287499785423279]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dff9910>: [11.31095027923584, 0.9513999819755554]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dff9a50>: [38.6794548034668, 0.866599977016449]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dff9b90>: [34.076026916503906, 0.8803250193595886]

Global model test performance : [13.61063003540039, 0.9423249959945679]

#### Accuracy round 4

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x10b24ced0>: [11.109318733215332, 0.9506250023841858]

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a3dfef450>: [15.064861297607422, 0.9423499703407288]

Test performance client <shfl.private.federated\_operation.FederatedDataNode

```

object at 0x1a3df6b610>: [17.385099411010742, 0.9297000169754028]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1a3df6b750>: [19.604276657104492, 0.9211999773979187]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1a3df6b890>: [14.391618728637695, 0.9439250230789185]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1a3df6bad0>: [11.12531566619873, 0.962149977684021]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1a3df6bb50>: [18.375057220458984, 0.9244250059127808]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1a3df6bc90>: [15.297127723693848, 0.9499250054359436]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1a3df6bdd0>: [62.63825607299805, 0.8258749842643738]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1a3df6bf50>: [17.275014877319336, 0.9313499927520752]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1a3dff9050>: [56.04662322998047, 0.869825005531311]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1a3dff9190>: [39.402122497558594, 0.8636749982833862]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1a3dff92d0>: [31.84327507019043, 0.8959000110626221]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1a3dff9410>: [27.475149154663086, 0.9077000021934509]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1a3dff9550>: [23.12981605529785, 0.9187750220298767]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1a3dff9690>: [37.57992935180664, 0.8797500133514404]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1a3dff97d0>: [16.133358001708984, 0.9393249750137329]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1a3dff9910>: [18.538175582885742, 0.9321749806404114]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1a3dff9a50>: [24.743871688842773, 0.9003000259399414]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1a3dff9b90>: [32.016605377197266, 0.8879749774932861]
Global model test performance : [15.29053783416748, 0.941224992275238]

```

## 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 0x1a4c790d10>: (0.6666666666666665, 0.648071776267088, 0.6572377238481567, 0.5956354300385108)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4c790f50>: (0.516477095100738, 0.6109003499683466, 0.5597345228568793, 0.4444444444444445)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x10b2441d0>: (1.0, 1.0, 1.0, 1.0)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4bf16290>: (0.7157016367384774, 0.8557165845714431, 0.779471374147003, 0.7141190198366395)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4a06d350>: (0.737175493807016, 0.737175493807016, 0.737175493807016, 0.6022727272727273)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4c7c6410>: (0.5539187664098593, 0.6551871737657903, 0.6003121132746836, 0.5267489711934157)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4c7c6590>: (0.8185762098314806, 0.8715196939868509, 0.8442187053237568, 0.8288508557457213)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4c7c6a90>: (0.8185762098314806, 0.8715196939868509, 0.8442187053237568, 0.8288508557457213)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472fff90>: (0.647734387847384, 0.6896282456067567, 0.6680251389357746, 0.6149144254278728)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4c7c6950>: (1.0, 1.0, 1.0, 1.0)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ff9d0>: (0.8185762098314806, 0.8715196939868509, 0.8442187053237568, 0.8288508557457213)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ff6d0>: (0.7157016367384774, 0.8557165845714431, 0.779471374147003, 0.7141190198366395)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ff950>: (0.7873419912288894, 0.7653811841780586, 0.7762062873080261, 0.6854942233632862)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ffa10>: (0.7157016367384774, 0.8557165845714431, 0.779471374147003, 0.7141190198366395)

Test performance client <shfl.private.federated\_operation.FederatedDataNode

object at 0x1a472ffa50>: (0.7157016367384774, 0.8557165845714431, 0.779471374147003, 0.7141190198366395)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ff990>: (0.737175493807016, 0.737175493807016, 0.737175493807016, 0.6022727272727273)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ffa90>: (0.737175493807016, 0.737175493807016, 0.737175493807016, 0.6022727272727273)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ffbd0>: (0.7157016367384774, 0.8557165845714431, 0.779471374147003, 0.7141190198366395)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ff710>: (0.5539187664098593, 0.6551871737657903, 0.6003121132746836, 0.5267489711934157)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ff050>: (0.8185762098314806, 0.8715196939868509, 0.8442187053237568, 0.8288508557457213)

Global model test performance : (0.8185762098314806, 0.8715196939868509, 0.8442187053237568, 0.8288508557457213)

#### Accuracy round 1

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4c790d10>: (0.6666666666666665, 0.648071776267088, 0.6572377238481567, 0.5956354300385108)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4c790f50>: (0.4841113491480843, 0.7391541418315879, 0.5850453748088784, 0.49218749999999994)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x10b2441d0>: (1.0, 1.0, 1.0, 1.0)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4bf16290>: (0.7157016367384774, 0.8557165845714431, 0.779471374147003, 0.7141190198366395)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4a06d350>: (0.6379740263133312, 0.7255272644267741, 0.6789396581138586, 0.4690781796966161)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4c7c6410>: (0.5539187664098593, 0.6551871737657903, 0.6003121132746836, 0.5267489711934157)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4c7c6590>: (0.8185762098314806, 0.8715196939868509, 0.8442187053237568, 0.8288508557457213)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4c7c6a90>: (0.8185762098314806, 0.8715196939868509, 0.8442187053237568, 0.8288508557457213)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472fff90>: (0.8185762098314806, 0.8715196939868509,



0.8442187053237568, 0.8288508557457213)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4c7c6950>: (0.8185762098314806, 0.8715196939868509, 0.8442187053237568, 0.8288508557457213)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ff9d0>: (0.8185762098314806, 0.8715196939868509, 0.8442187053237568, 0.8288508557457213)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ff6d0>: (0.7157016367384774, 0.8557165845714431, 0.779471374147003, 0.7141190198366395)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ff950>: (0.7873419912288893, 0.7653811841780586, 0.7762062873080259, 0.6854942233632862)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ffa10>: (0.8185762098314806, 0.8715196939868509, 0.8442187053237568, 0.8288508557457213)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ffa50>: (0.7157016367384774, 0.8557165845714431, 0.779471374147003, 0.7141190198366395)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ff990>: (1.0, 1.0, 1.0, 1.0)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ffa90>: (0.737175493807016, 0.737175493807016, 0.737175493807016, 0.6022727272727273)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ffbd0>: (0.7157016367384774, 0.8557165845714431, 0.779471374147003, 0.7141190198366395)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ff710>: (0.5539187664098593, 0.6551871737657903, 0.6003121132746836, 0.5267489711934157)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ff050>: (0.8185762098314806, 0.8715196939868509, 0.8442187053237568, 0.8288508557457213)

Global model test performance : (0.8185762098314805, 0.8715196939868508, 0.8442187053237569, 0.8288508557457213)

#### Accuracy round 2

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4c790d10>: (0.6666666666666666, 0.6480717762670881, 0.6572377238481568, 0.5956354300385108)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4c790f50>: (0.7084828534536808, 0.7084828534536808, 0.7084828534536808, 0.6906565656565657)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x10b2441d0>: (1.0, 1.0, 1.0, 1.0)

Test performance client <shfl.private.federated\_operation.FederatedDataNode

object at 0x1a4bf16290>: (0.7157016367384774, 0.8557165845714431, 0.779471374147003, 0.7141190198366395)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4a06d350>: (0.6379740263133312, 0.7255272644267741, 0.6789396581138586, 0.4690781796966161)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4c7c6410>: (0.5539187664098592, 0.6551871737657902, 0.6003121132746835, 0.5267489711934157)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4c7c6590>: (0.8185762098314805, 0.8715196939868508, 0.8442187053237569, 0.8288508557457213)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4c7c6a90>: (0.8185762098314805, 0.8715196939868508, 0.8442187053237569, 0.8288508557457213)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472fff90>: (0.8185762098314805, 0.8715196939868508, 0.8442187053237569, 0.8288508557457213)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4c7c6950>: (0.8185762098314805, 0.8715196939868508, 0.8442187053237569, 0.8288508557457213)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ff9d0>: (0.8185762098314805, 0.8715196939868508, 0.8442187053237569, 0.8288508557457213)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ff6d0>: (0.7157016367384774, 0.8557165845714431, 0.779471374147003, 0.7141190198366395)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ff950>: (0.7873419912288894, 0.7653811841780586, 0.7762062873080261, 0.6854942233632862)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ffa10>: (0.8185762098314805, 0.8715196939868508, 0.8442187053237569, 0.8288508557457213)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ffa50>: (0.7157016367384774, 0.8557165845714431, 0.779471374147003, 0.7141190198366395)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ff990>: (1.0, 1.0, 1.0, 1.0)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ffa90>: (0.737175493807016, 0.737175493807016, 0.737175493807016, 0.6022727272727273)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ffbd0>: (0.8185762098314805, 0.8715196939868508, 0.8442187053237569, 0.8288508557457213)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ff710>: (0.5539187664098592, 0.6551871737657902, 0.6003121132746835, 0.5267489711934157)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ff050>: (0.8185762098314805, 0.8715196939868508,

0.8442187053237569, 0.8288508557457213)  
Global model test performance : (0.8185762098314804, 0.8715196939868507,  
0.8442187053237565, 0.8288508557457213)

Accuracy round 3

Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4c790d10>: (0.6666666666666665, 0.648071776267088,  
0.6572377238481567, 0.5956354300385108)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4c790f50>: (0.7084828534536808, 0.7084828534536808,  
0.7084828534536808, 0.6906565656565657)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x10b2441d0>: (1.0, 1.0, 1.0, 1.0)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4bf16290>: (0.7157016367384774, 0.8557165845714431,  
0.779471374147003, 0.7141190198366395)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4a06d350>: (0.6379740263133311, 0.7255272644267738,  
0.6789396581138584, 0.4690781796966161)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4c7c6410>: (0.5539187664098593, 0.6551871737657903,  
0.6003121132746836, 0.5267489711934157)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4c7c6590>: (0.8185762098314804, 0.8715196939868507,  
0.8442187053237565, 0.8288508557457213)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4c7c6a90>: (0.8185762098314804, 0.8715196939868507,  
0.8442187053237565, 0.8288508557457213)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a472fff90>: (0.8185762098314804, 0.8715196939868507,  
0.8442187053237565, 0.8288508557457213)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4c7c6950>: (0.8185762098314804, 0.8715196939868507,  
0.8442187053237565, 0.8288508557457213)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a472ff9d0>: (0.8185762098314804, 0.8715196939868507,  
0.8442187053237565, 0.8288508557457213)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a472ff6d0>: (0.7157016367384774, 0.8557165845714431,  
0.779471374147003, 0.7141190198366395)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a472ff950>: (0.7873419912288894, 0.7653811841780586,  
0.7762062873080261, 0.6854942233632862)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a472ffa10>: (0.8185762098314804, 0.8715196939868507,  
0.8442187053237565, 0.8288508557457213)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ffa50>: (0.7157016367384774, 0.8557165845714431, 0.779471374147003, 0.7141190198366395)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ff990>: (1.0, 1.0, 1.0, 1.0)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ffa90>: (0.737175493807016, 0.737175493807016, 0.737175493807016, 0.6022727272727273)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ffbd0>: (0.8185762098314804, 0.8715196939868507, 0.8442187053237565, 0.8288508557457213)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ff710>: (0.5539187664098593, 0.6551871737657903, 0.6003121132746836, 0.5267489711934157)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472ff050>: (0.8185762098314804, 0.8715196939868507, 0.8442187053237565, 0.8288508557457213)

Global model test performance : (0.8185762098314804, 0.8715196939868507, 0.8442187053237565, 0.8288508557457213)

#### Accuracy round 4

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4c790d10>: (0.6666666666666665, 0.648071776267088, 0.6572377238481567, 0.5956354300385108)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4c790f50>: (0.7084828534536808, 0.7084828534536808, 0.7084828534536808, 0.6906565656565657)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x10b2441d0>: (1.0, 1.0, 1.0, 1.0)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4bf16290>: (0.7157016367384774, 0.8557165845714431, 0.779471374147003, 0.7141190198366395)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4a06d350>: (0.6379740263133311, 0.7255272644267738, 0.6789396581138584, 0.4690781796966161)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4c7c6410>: (0.5539187664098593, 0.6551871737657903, 0.6003121132746836, 0.5267489711934157)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4c7c6590>: (0.8185762098314804, 0.8715196939868507, 0.8442187053237565, 0.8288508557457213)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4c7c6a90>: (0.8185762098314804, 0.8715196939868507, 0.8442187053237565, 0.8288508557457213)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a472fff90>: (0.8185762098314804, 0.8715196939868507,

```

0.8442187053237565, 0.8288508557457213)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1a4c7c6950>: (0.8185762098314804, 0.8715196939868507,
0.8442187053237565, 0.8288508557457213)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1a472ff9d0>: (0.8185762098314804, 0.8715196939868507,
0.8442187053237565, 0.8288508557457213)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1a472ff6d0>: (0.7157016367384774, 0.8557165845714431,
0.779471374147003, 0.7141190198366395)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1a472ff950>: (0.7873419912288894, 0.7653811841780586,
0.7762062873080261, 0.6854942233632862)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1a472ffa10>: (0.8185762098314804, 0.8715196939868507,
0.8442187053237565, 0.8288508557457213)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1a472ffa50>: (0.7157016367384774, 0.8557165845714431,
0.779471374147003, 0.7141190198366395)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1a472ff990>: (1.0, 1.0, 1.0, 1.0)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1a472ffa90>: (0.737175493807016, 0.737175493807016,
0.737175493807016, 0.6022727272727273)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1a472ffbd0>: (0.8185762098314804, 0.8715196939868507,
0.8442187053237565, 0.8288508557457213)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1a472ff710>: (0.5539187664098593, 0.6551871737657903,
0.6003121132746836, 0.5267489711934157)
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1a472ff050>: (0.8185762098314804, 0.8715196939868507,
0.8442187053237565, 0.8288508557457213)
Global model test performance : (0.8185762098314804, 0.8715196939868507,
0.8442187053237565, 0.8288508557457213)

```

### 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 [feder-](#)

ated\_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 0x10b240f90>: (0.7919497365014289, 0.5575214265091708)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4c7bd490>: (0.7199979413009614, 0.6342708999250697)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4bf16710>: (0.8583304425228283, 0.4802361867052497)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a492566d0>: (0.855049779467989, 0.48420181847636323)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4aab0bd0>: (0.8471450479984304, 0.493694598032525)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4aab0a50>: (0.8446628376179791, 0.49665729095784583)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4aab0e50>: (0.7184067028141855, 0.6358856799147932)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4aab0910>: (0.727696501772104, 0.626407987459546)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4aab07d0>: (0.7919894205038014, 0.5574770808647618)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4aab0810>: (0.8589174895707666, 0.4795249684120011)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4aab0f90>: (0.8584156424772659, 0.48013299555909383)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4aab0850>: (0.929151417747116, 0.39092609114482524)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4aab0890>: (0.7283749959888001, 0.6257109985639326)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4a0687d0>: (0.7246950375716167, 0.629483474392409)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4a068f10>: (0.8247354637003816, 0.520126964315663)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4a068c10>: (0.7195646093237839, 0.6347109968020039)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4a068fd0>: (0.7508268407908194, 0.6022807726010146)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4a068d10>: (0.876349899469372, 0.4581836698104932)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4a068710>: (0.788886835905069, 0.5609374188255054)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4a068250>: (0.8957070194866962, 0.4339836668979715)  
Global model test performance : (0.7647026505364183, 0.5874446731302585)

Accuracy round 1

Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x10b240f90>: (0.7919497365014289, 0.5575214265091708)

Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4c7bd490>: (0.7199979413009614, 0.6342708999250697)

Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4bf16710>: (0.8583304425228283, 0.4802361867052497)

Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a492566d0>: (0.855049779467989, 0.48420181847636323)

Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4aab0bd0>: (0.8471450479984304, 0.493694598032525)

Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4aab0a50>: (0.8446628376179791, 0.49665729095784583)

Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4aab0e50>: (0.7184067028141855, 0.6358856799147932)

Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4aab0910>: (0.727696501772104, 0.626407987459546)

Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4aab07d0>: (0.7919894205038014, 0.5574770808647618)

Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4aab0810>: (0.8589174895707666, 0.4795249684120011)

Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4aab0f90>: (0.8584156424772659, 0.48013299555909383)

Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4aab0850>: (0.929151417747116, 0.39092609114482524)

Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4aab0890>: (0.7283749959888001, 0.6257109985639326)

Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4a0687d0>: (0.7246950375716167, 0.629483474392409)

Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4a068f10>: (0.8247354637003816, 0.520126964315663)

Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4a068c10>: (0.7195646093237839, 0.6347109968020039)

Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4a068fd0>: (0.7508268407908194, 0.6022807726010146)

Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4a068d10>: (0.876349899469372, 0.4581836698104932)

Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4a068710>: (0.788886835905069, 0.5609374188255054)

Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4a068250>: (0.8957070194866962, 0.4339836668979715)

Global model test performance : (0.7647026505364183, 0.5874446731302585)

#### Accuracy round 2

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x10b240f90>: (0.7919497365014289, 0.5575214265091708)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4c7bd490>: (0.7199979413009614, 0.6342708999250697)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4bf16710>: (0.8583304425228283, 0.4802361867052497)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a492566d0>: (0.855049779467989, 0.48420181847636323)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4aab0bd0>: (0.8471450479984304, 0.493694598032525)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4aab0a50>: (0.8446628376179791, 0.49665729095784583)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4aab0e50>: (0.7184067028141855, 0.6358856799147932)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4aab0910>: (0.727696501772104, 0.626407987459546)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4aab07d0>: (0.7919894205038014, 0.5574770808647618)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4aab0810>: (0.8589174895707666, 0.4795249684120011)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4aab0f90>: (0.8584156424772659, 0.48013299555909383)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4aab0850>: (0.929151417747116, 0.39092609114482524)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4aab0890>: (0.7283749959888001, 0.6257109985639326)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4a0687d0>: (0.7246950375716167, 0.629483474392409)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4a068f10>: (0.8247354637003816, 0.520126964315663)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4a068c10>: (0.7195646093237839, 0.6347109968020039)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4a068fd0>: (0.7508268407908194, 0.6022807726010146)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4a068d10>: (0.876349899469372, 0.4581836698104932)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4a068710>: (0.788886835905069, 0.5609374188255054)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4a068250>: (0.8957070194866962, 0.4339836668979715)

Global model test performance : (0.7647026505364183, 0.5874446731302585)

#### Accuracy round 3

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x10b240f90>: (0.7919497365014289, 0.5575214265091708)



Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4c7bd490>: (0.7199979413009614, 0.6342708999250697)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4bf16710>: (0.8583304425228283, 0.4802361867052497)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a492566d0>: (0.855049779467989, 0.48420181847636323)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4aab0bd0>: (0.8471450479984304, 0.493694598032525)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4aab0a50>: (0.8446628376179791, 0.49665729095784583)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4aab0e50>: (0.7184067028141855, 0.6358856799147932)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4aab0910>: (0.727696501772104, 0.626407987459546)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4aab07d0>: (0.7919894205038014, 0.5574770808647618)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4aab0810>: (0.8589174895707666, 0.4795249684120011)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4aab0f90>: (0.8584156424772659, 0.48013299555909383)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4aab0850>: (0.929151417747116, 0.39092609114482524)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4aab0890>: (0.7283749959888001, 0.6257109985639326)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4a0687d0>: (0.7246950375716167, 0.629483474392409)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4a068f10>: (0.8247354637003816, 0.520126964315663)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4a068c10>: (0.7195646093237839, 0.6347109968020039)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4a068fd0>: (0.7508268407908194, 0.6022807726010146)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4a068d10>: (0.876349899469372, 0.4581836698104932)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4a068710>: (0.788886835905069, 0.5609374188255054)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4a068250>: (0.8957070194866962, 0.4339836668979715)

Global model test performance : (0.7647026505364183, 0.5874446731302585)

#### Accuracy round 4

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x10b240f90>: (0.7919497365014289, 0.5575214265091708)

Test performance client <shfl.private.federated\_operation.FederatedDataNode object at 0x1a4c7bd490>: (0.7199979413009614, 0.6342708999250697)

Test performance client <shfl.private.federated\_operation.FederatedDataNode

object at 0x1a4bf16710>: (0.8583304425228283, 0.4802361867052497)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a492566d0>: (0.855049779467989, 0.48420181847636323)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4aab0bd0>: (0.8471450479984304, 0.493694598032525)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4aab0a50>: (0.8446628376179791, 0.49665729095784583)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4aab0e50>: (0.7184067028141855, 0.6358856799147932)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4aab0910>: (0.727696501772104, 0.626407987459546)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4aab07d0>: (0.7919894205038014, 0.5574770808647618)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4aab0810>: (0.8589174895707666, 0.4795249684120011)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4aab0f90>: (0.8584156424772659, 0.48013299555909383)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4aab0850>: (0.929151417747116, 0.39092609114482524)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4aab0890>: (0.7283749959888001, 0.6257109985639326)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4a0687d0>: (0.7246950375716167, 0.629483474392409)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4a068f10>: (0.8247354637003816, 0.520126964315663)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4a068c10>: (0.7195646093237839, 0.6347109968020039)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4a068fd0>: (0.7508268407908194, 0.6022807726010146)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4a068d10>: (0.876349899469372, 0.4581836698104932)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4a068710>: (0.788886835905069, 0.5609374188255054)  
Test performance client <shfl.private.federated\_operation.FederatedDataNode  
object at 0x1a4a068250>: (0.8957070194866962, 0.4339836668979715)  
Global model test performance : (0.7647026505364183, 0.5874446731302585)