federated_models_regression_deeplearning

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1 Federated learning: regression using the California Housing database

In this notebook we are going to show how you can use a federated learning environment to create a regression model. In the notebook on the Linear regression for a 2D simple case we explained the basic concepts of the framework, so now we will go slightly faster.

First of all, we load a dataset (included in the framework) to allow for regression experiments.

[1]:
```
import shfl
from shfl.data_base.california_housing import CaliforniaHousing

database = CaliforniaHousing()
train_data, train_labels, test_data, test_labels = database.load_data()
```

We are going to explore the data

[2]:
```
print("Shape of train_data: " + str(train_data.shape))
print("Shape of train_labels: " + str(train_labels.shape))
print("One sample features: " + str(train_data[0]))
print("One sample label: " + str(train_labels[0]))
```

```
Shape of train_data: (18576, 8)
Shape of train_labels: (18576,)
One sample features: [   2.7305       16.            5.29865772    1.09731544
934.
    3.13422819   34.9        -117.16      ]
One sample label: 0.738
```

Federeted data generation:

[3]:
```
import shfl

iid_distribution = shfl.data_distribution.IidDataDistribution(database)
federated_data, test_data, test_label = iid_distribution.get_federated_data(20,␣
 ↪percent=10)
```

Model definition:

[4]:
```
import tensorflow as tf

def model_builder():
    # create model
    model = tf.keras.models.Sequential()
    model.add(tf.keras.layers.Dense(8, input_dim=8,␣
 ↪kernel_initializer='normal', activation='relu'))
    model.add(tf.keras.layers.Dense(1, kernel_initializer='normal'))

    # Compile model
    model.compile(loss='mean_squared_error', optimizer='adam', metrics=["mae"])

    return shfl.model.DeepLearningModel(model)
```

Federated environment definition:

[5]:
```
aggregator = shfl.federated_aggregator.FedAvgAggregator()
federated_government = shfl.federated_government.
 ↪FederatedGovernment(model_builder, federated_data, aggregator)
```

Reshaping data:

[6]:
```
import numpy as np

class Reshape(shfl.private.FederatedTransformation):

    def apply(self, labeled_data):
        labeled_data.label = np.reshape(labeled_data.label, (labeled_data.label.
 ↪shape[0], 1))

shfl.private.federated_operation.apply_federated_transformation(federated_data,␣
 ↪Reshape())
```

Running experiment:

[7]:
```
test_label = np.reshape(test_label, (test_label.shape[0], 1))
federated_government.run_rounds(3, test_data, test_label)
```

```
Accuracy round 0
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x103011150>: [4.7616777420043945, 1.524004578590393]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x103011190>: [4.296876907348633, 1.4683102369308472]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f1210>: [4.66226053237915, 1.5123190879821777]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f1390>: [4.398004055023193, 1.481758952140808]
Test performance client <shfl.private.federated_operation.FederatedDataNode
```

```
object at 0x1321f14d0>: [4.350432395935059, 1.4768716096878052]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f1710>: [4.311580657958984, 1.469742774963379]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f1790>: [4.253408432006836, 1.4644008874893188]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f18d0>: [4.317190170288086, 1.4680964946746826]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f1a10>: [4.675190448760986, 1.5113742351531982]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f1b90>: [4.692774295806885, 1.5159361362457275]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f1c50>: [4.399670124053955, 1.4776650667190552]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f1d90>: [4.361093044281006, 1.4778318405151367]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f1ed0>: [4.311219215393066, 1.4674625396728516]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f5050>: [4.691488265991211, 1.5156501531600952]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f5190>: [4.372124195098877, 1.478882908821106]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f52d0>: [4.602834224700928, 1.5050334930419922]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f5410>: [4.545685291290283, 1.4977145195007324]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f5550>: [4.458195686340332, 1.4884177446365356]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f5690>: [4.2621331214904785, 1.4628889560699463]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f57d0>: [4.392319679260254, 1.4789897203445435]
Global model test performance : [4.4479546546936035, 1.4861228466033936]



Accuracy round 1
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x103011150>: [3.634617567062378, 1.398324728012085]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x103011190>: [3.5297739505767822, 1.3923801183700562]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f1210>: [3.655149459838867, 1.4045130014419556]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f1390>: [3.570340871810913, 1.401780366897583]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f14d0>: [3.5668869018554688, 1.409946084022522]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f1710>: [3.568979263305664, 1.383474349975586]
```

```
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f1790>: [3.567213535308838, 1.4144783020019531]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f18d0>: [3.511549711227417, 1.376644492149353]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f1a10>: [3.6131582260131836, 1.3857927322387695]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f1b90>: [3.6256606578826904, 1.3942772150039673]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f1c50>: [3.5736820697784424, 1.3947696685791016]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f1d90>: [3.566464900970459, 1.4013752937316895]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f1ed0>: [3.5131397247314453, 1.382873296737671]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f5050>: [3.6357064247131348, 1.3970282077789307]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f5190>: [3.5880210399627686, 1.4104766845703125]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f52d0>: [3.6113502979278564, 1.394346833229065]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f5410>: [3.6333441734313965, 1.3921884298324585]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f5550>: [3.582354784011841, 1.3959505558013916]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f5690>: [3.5331854820251465, 1.3943063020706177]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f57d0>: [3.569768190383911, 1.3855026960372925]
Global model test performance : [3.569491386413574, 1.3925938606262207]



Accuracy round 2
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x103011150>: [3.5167338848114014, 1.4225420951843262]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x103011190>: [3.4525134563446045, 1.3972984552383423]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f1210>: [3.603087902069092, 1.451994776725769]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f1390>: [3.596679449081421, 1.4539903402328491]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f14d0>: [3.6709907054901123, 1.480047583580017]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f1710>: [3.439058303833008, 1.3699381351470947]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f1790>: [3.6813881397247314, 1.4824693202972412]
Test performance client <shfl.private.federated_operation.FederatedDataNode
```

```
object at 0x1321f18d0>: [3.408895492553711, 1.3716219663619995]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f1a10>: [3.419375419616699, 1.3712868690490723]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f1b90>: [3.4774863719940186, 1.406190276145935]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f1c50>: [3.503965377807617, 1.4178060293197632]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f1d90>: [3.57867169380188, 1.4472482204437256]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f1ed0>: [3.4290273189544678, 1.3885166645050049]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f5050>: [3.4776406288146973, 1.4047197103500366]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f5190>: [3.7195358276367188, 1.4937875270843506]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f52d0>: [3.468289613723755, 1.3998810052871704]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f5410>: [3.4387338161468506, 1.376989483833313]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f5550>: [3.542884588241577, 1.4340697526931763]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f5690>: [3.539829730987549, 1.4343676567077637]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x1321f57d0>: [3.428769826889038, 1.3774821758270264]
Global model test performance : [3.489001750946045, 1.412266492843628]
```

[ ]: