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: [ 4.09090000e+00  3.40000000e+01  6.15186916e+00
1.10046729e+00
  1.31300000e+03  3.06775701e+00  3.42200000e+01 -1.18620000e+02]
One sample label: 2.329
```

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 0x13f412410>: [9.325024604797363, 2.8089373111724854]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f412510>: [9.348034858703613, 2.8126044273376465]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f412650>: [9.359216690063477, 2.814417839050293]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f412790>: [9.404626846313477, 2.821747303009033]
Test performance client <shfl.private.federated_operation.FederatedDataNode
```

```
object at 0x13f4128d0>: [9.355212211608887, 2.8137574195861816]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f412b10>: [9.332915306091309, 2.810330629348755]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f412b90>: [9.341217041015625, 2.8116886615753174]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f412cd0>: [9.751830101013184, 2.8780877590179443]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f412e10>: [9.344169616699219, 2.8120803833007812]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f412f90>: [9.356843948364258, 2.814049243927002]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f418090>: [9.411582946777344, 2.822967767715454]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f4181d0>: [9.385908126831055, 2.818878650665283]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f418310>: [9.368647575378418, 2.8160552978515625]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f418450>: [9.43278980255127, 2.8262476921081543]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f418590>: [9.331818580627441, 2.810211658477783]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f4186d0>: [9.383875846862793, 2.818478584289551]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f418810>: [9.329172134399414, 2.8097083568573]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f418950>: [9.391417503356934, 2.8196237087249756]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f418a90>: [9.409069061279297, 2.822669506072998]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f418bd0>: [9.388650894165039, 2.8194146156311035]
Global model test performance : [9.386951446533203, 2.819049596786499]



Accuracy round 1
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f412410>: [6.475170612335205, 2.2570929527282715]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f412510>: [6.498298645019531, 2.262392520904541]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f412650>: [6.509249210357666, 2.264958143234253]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f412790>: [6.5310492515563965, 2.2700023651123047]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f4128d0>: [6.505132675170898, 2.264042615890503]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f412b10>: [6.499802589416504, 2.2627556324005127]
```

```
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f412b90>: [6.507442951202393, 2.2643940448760986]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f412cd0>: [7.061850547790527, 2.3866024017333984]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f412e10>: [6.481734275817871, 2.2586264610290527]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f412f90>: [6.491969585418701, 2.260929822921753]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f418090>: [6.56782865524292, 2.278411388397217]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f4181d0>: [6.532308101654053, 2.2701380252838135]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f418310>: [6.524500370025635, 2.268423318862915]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f418450>: [6.563844680786133, 2.277419328689575]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f418590>: [6.519617080688477, 2.267324686050415]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f4186d0>: [6.512997150421143, 2.2657418251037598]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f418810>: [6.53937292098999, 2.271838665008545]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f418950>: [6.520351409912109, 2.267495632171631]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f418a90>: [6.537816047668457, 2.2714786529541016]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f418bd0>: [6.6472954750061035, 2.2962613105773926]
Global model test performance : [6.550066947937012, 2.2742793560028076]



Accuracy round 2
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f412410>: [4.626210689544678, 1.7749701738357544]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f412510>: [4.631925582885742, 1.7764233350753784]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f412650>: [4.639651298522949, 1.7788711786270142]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f412790>: [4.663677215576172, 1.7860891819000244]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f4128d0>: [4.637256622314453, 1.7782058715820312]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f412b10>: [4.654989242553711, 1.783553957939148]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f412b90>: [4.663454532623291, 1.7858173847198486]
Test performance client <shfl.private.federated_operation.FederatedDataNode
```

```
object at 0x13f412cd0>: [5.142861843109131, 1.9239330291748047]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f412e10>: [4.619898796081543, 1.7731051445007324]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f412f90>: [4.634900093078613, 1.7774629592895508]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f418090>: [4.67043399810791, 1.7881436347961426]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f4181d0>: [4.647876739501953, 1.7812235355377197]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f418310>: [4.651865482330322, 1.7824363708496094]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f418450>: [4.697579383850098, 1.7958614826202393]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f418590>: [4.642955303192139, 1.779946208000183]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f4186d0>: [4.636091709136963, 1.7777537107467651]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f418810>: [4.697511672973633, 1.796161413192749]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f418950>: [4.659533500671387, 1.784753441810608]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f418a90>: [4.662242412567139, 1.785585880279541]
Test performance client <shfl.private.federated_operation.FederatedDataNode
object at 0x13f418bd0>: [4.727131366729736, 1.8046889305114746]
Global model test performance : [4.678576946258545, 1.7904356718063354]
```

[ ]: