0724-small_hybrid_model_v4

July 25, 2023

[1]:
```
import torch
import torch.nn as nn
import torch.optim as optim
```

[2]:
```
import numpy as np
```

[3]:
```
import sys
sys.path.append('..')

from my_code import functions as f
```

1 Data

[4]:
```
file_path = '../data/energies/Trial/Strings_Energies_4_aa.txt'  # Replace with␣
 ↪the actual path to your 'data.txt' file
string_list, number_list = f.read_data_file(file_path)
score_list = np.array(number_list)/1000
angles_list = np.array([f.string_to_numbers(string) for string in string_list])
```

[5]:
```
X, Y, X_validation, Y_validation = f.create_validating_set(angles_list,␣
 ↪score_list, percentage=0.1)
```

[6]:
```
# Define the dataset
input_data = torch.tensor(X, dtype=torch.float32)
target_data = torch.tensor(Y, dtype=torch.float32).view(-1, 1)

# Define the validation set
input_validation = torch.tensor(X_validation, dtype=torch.float32)
target_validation = torch.tensor(Y_validation, dtype=torch.float32).view(-1, 1)
```

2 Quantum node

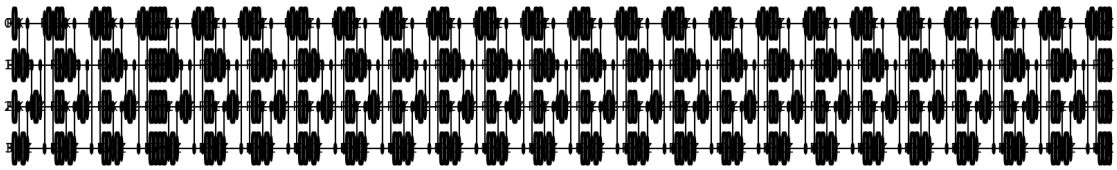
[7]:
```
def qml_RZZ(params, wires):
    """
    RZZ gate.
    """
```

```
    qml.CNOT(wires=wires)
    qml.RZ(params, wires=wires[1])
    qml.CNOT(wires=wires)
```

[8]:
```
import pennylane as qml

n_qubits = 4
n_layers_block = 20
n_layers_embedding = 3
n_layers = n_layers_block + n_layers_embedding
n_params = 5
dev = qml.device("default.qubit", wires=n_qubits)

@qml.qnode(dev)
def qnode(inputs, weights):

    # state preparation (we create an embedding with 3 layers, paper: 2001.
 ↪03622)
    for i in range(n_layers_embedding):

        # angle embedding for each qubit
        qml.AngleEmbedding(inputs, wires=range(n_qubits))

        # ZZ rotation for neighboring qubits
        for x in range(2):
            for j in range(x,n_qubits,2):
                qml_RZZ(weights[i,j,0], wires=[j, (j+1)%n_qubits])

        # rotations for each qubit
        for j in range(n_qubits):
            qml.RY(weights[i,j,1], wires=j)

        # last angle embedding
    qml.AngleEmbedding(inputs, wires=range(n_qubits))

    #layers
    for i in range(n_layers_embedding, n_layers):
        # rotations for each qubit
        for j in range(n_qubits):
            qml.RX(weights[i,j,2], wires=j)
            qml.RZ(weights[i,j,3], wires=j)

        # ZZ rotation for neighboring qubits
        for x in range(2):
            for j in range(x,n_qubits,2):
                qml_RZZ(weights[i,j,4], wires=[j, (j+1)%n_qubits])
```

```
    # rotations for each qubit
    for j in range(n_qubits):
        qml.RX(weights[i,j,0], wires=j)
        qml.RZ(weights[i,j,1], wires=j)

    # measurement
    return [qml.expval(qml.PauliZ(wires=i)) for i in range(n_qubits)]
```

[9]:
```
qml.drawer.use_style("black_white")
fig, ax = qml.draw_mpl(qnode, expansion_strategy="device")([i for i in␣
 ↪range(n_qubits)], np.zeros((n_layers, n_qubits, n_params)))
fig.set_size_inches((16,3))
```



[10]:
```
weight_shapes = {"weights": (n_layers, n_qubits, n_params)}
```

[11]:
```
qlayer = qml.qnn.TorchLayer(qnode, weight_shapes)
```

3 Hybrid model

[12]:
```
input_dim = input_data.size(1)

layers =  [nn.Linear(input_dim*1, input_dim*2), nn.ReLU()]
layers += [nn.Linear(input_dim*2, input_dim*3), nn.ReLU()]
layers += [nn.Linear(input_dim*3, input_dim*3), nn.ReLU()]
layers += [nn.Linear(input_dim*3, input_dim*2), nn.ReLU()]
layers += [nn.Linear(input_dim*2, input_dim*1)]
layers += [qlayer]
layers += [nn.Linear(input_dim*1, input_dim*1)]
layers += [nn.Linear(input_dim*1, input_dim*1), nn.ReLU()] * 2
layers += [nn.Linear(input_dim*1, 1          )]
Net = nn.Sequential(*layers)
```

[13]:
```
# Create an instance of the network
model = Net
```

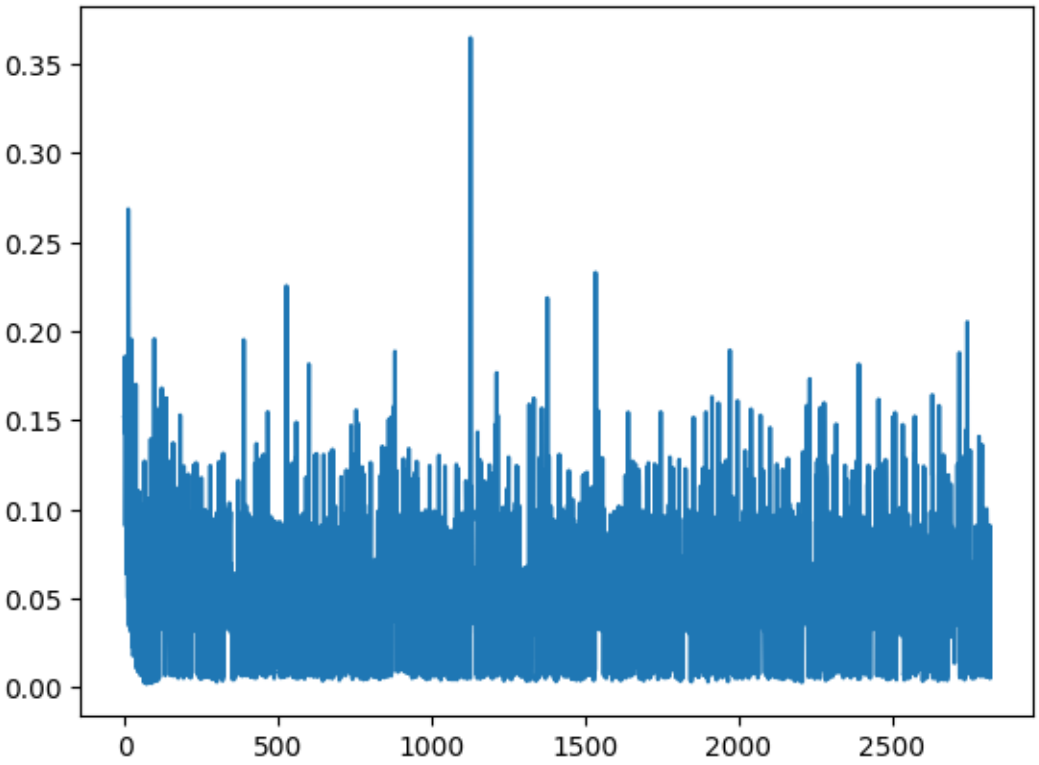
[14]:
```
import time
```

[15]:
```
# time
start_time = time.time()


# Define the loss function and optimizer
criterion = nn.MSELoss()  # Mean Squared Error loss
# optimizer = optim.Adam(model.parameters(), lr=0.001)  # Adam optimizer with␣
 ↪learning rate 0.001
optimizer = optim.SGD(model.parameters(), lr=0.01)

# Training loop
num_epochs = 10
batch_size = 32

losses = []
losses_epochs = []

for epoch in range(num_epochs):
    # Shuffle the dataset
    indices = torch.randperm(input_data.size(0))
    input_data = input_data[indices]
    target_data = target_data[indices]

    losses_epochs.append(0)

    # Mini-batch training
    for i in range(0, input_data.size(0), batch_size):
        inputs = input_data[i:i+batch_size]
        targets = target_data[i:i+batch_size]

        # Forward pass
        outputs = model(inputs)

        # Compute the loss
        loss = criterion(outputs, targets)

        # Backward pass and optimization
        optimizer.zero_grad()
        loss.backward()
        optimizer.step()

        # Store the loss
        losses.append(loss.item())

        print('- Epoch [{}/{}], i: [{}/{}], Loss: {:.4f}'.format(epoch+1,␣
 ↪num_epochs, i, input_data.size(0), loss.item()), end='\r')
```

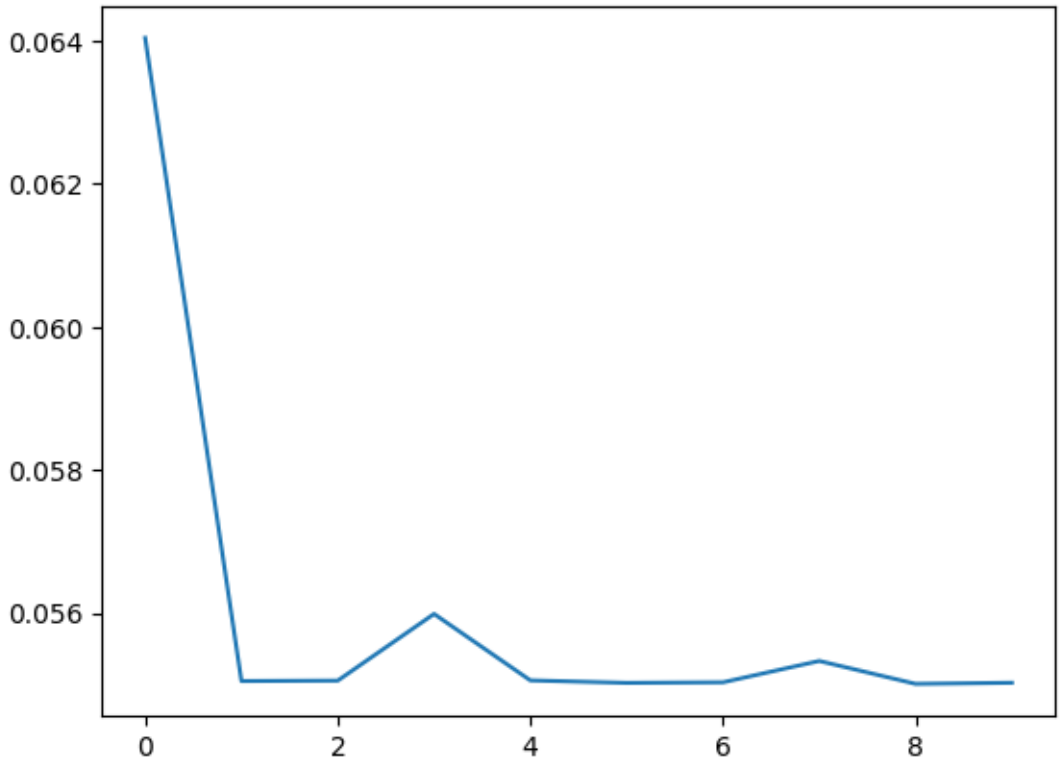
```
        # add to the epoch loss
        losses_epochs[-1] += loss.item() / (input_data.size(0) / batch_size)

    # time
    # Compute elapsed time and remaining time
    elapsed_time = time.time() - start_time
    avg_time_per_epoch = elapsed_time / (epoch + 1)
    remaining_epochs = num_epochs - (epoch + 1)
    estimated_remaining_time = avg_time_per_epoch * remaining_epochs

    # Convert remaining time to hours, minutes, and seconds for better␣
↪readability
    hours, remainder = divmod(estimated_remaining_time, 3600)
    minutes, seconds = divmod(remainder, 60)

    # Print the loss and remaining time for this epoch
    print('Epoch [{}/{}], Loss: {:.4f}, Time remaining: ~{}h {}m {:.0f}s'.
↪format(
        epoch+1, num_epochs, losses_epochs[-1], hours, minutes, seconds))
```

```
Epoch [1/10], Loss: 0.0640, Time remaining: ~0.0h 30.0m 57s
Epoch [2/10], Loss: 0.0550, Time remaining: ~0.0h 26.0m 53s
Epoch [3/10], Loss: 0.0551, Time remaining: ~0.0h 23.0m 28s
Epoch [4/10], Loss: 0.0560, Time remaining: ~0.0h 20.0m 10s
Epoch [5/10], Loss: 0.0551, Time remaining: ~0.0h 16.0m 54s
Epoch [6/10], Loss: 0.0550, Time remaining: ~0.0h 13.0m 29s
Epoch [7/10], Loss: 0.0550, Time remaining: ~0.0h 10.0m 0s
Epoch [8/10], Loss: 0.0553, Time remaining: ~0.0h 6.0m 33s
Epoch [9/10], Loss: 0.0550, Time remaining: ~0.0h 3.0m 14s
Epoch [10/10], Loss: 0.0550, Time remaining: ~0.0h 0.0m 0s
```

[16]:
```
#plot the loss
import matplotlib.pyplot as plt
plt.plot(losses)
plt.show()
```



[17]:
```
#plot the loss
import matplotlib.pyplot as plt
plt.plot(losses_epochs)
plt.show()
```



[18]:
```
avg_loss = 0
for x, (i, t) in enumerate(zip((input_validation), target_validation)):
    loss = criterion(model(i), t)
    avg_loss += loss/len(target_validation)
    print('i: {}, target: {:.3f}, output: {:.3f}, loss: {:.3f}'.format(x, t.
 ↪item(), model(i).item(), loss))
    print('')

print('Average loss: {:.3f}'.format(avg_loss))
```

```
i: 0, target: -0.153, output: -0.050, loss: 0.010

i: 1, target: -0.146, output: -0.048, loss: 0.010

i: 2, target: 0.897, output: -0.048, loss: 0.893

i: 3, target: -0.139, output: -0.052, loss: 0.007

i: 4, target: -0.123, output: -0.049, loss: 0.005

i: 5, target: -0.058, output: -0.050, loss: 0.000
```

```
i: 6, target: -0.079, output: -0.051, loss: 0.001

i: 7, target: -0.133, output: -0.052, loss: 0.007

i: 8, target: 0.969, output: -0.051, loss: 1.040

i: 9, target: -0.141, output: -0.052, loss: 0.008

i: 10, target: -0.068, output: -0.048, loss: 0.000

i: 11, target: -0.211, output: -0.052, loss: 0.025

i: 12, target: -0.148, output: -0.050, loss: 0.010

i: 13, target: -0.057, output: -0.049, loss: 0.000

i: 14, target: 0.961, output: -0.047, loss: 1.017

i: 15, target: -0.055, output: -0.052, loss: 0.000

i: 16, target: -0.161, output: -0.052, loss: 0.012

i: 17, target: -0.093, output: -0.050, loss: 0.002

i: 18, target: -0.157, output: -0.052, loss: 0.011

i: 19, target: -0.154, output: -0.052, loss: 0.011

i: 20, target: -0.021, output: -0.051, loss: 0.001

i: 21, target: -0.077, output: -0.048, loss: 0.001

i: 22, target: -0.069, output: -0.052, loss: 0.000

i: 23, target: 0.956, output: -0.048, loss: 1.009

i: 24, target: -0.292, output: -0.052, loss: 0.058

i: 25, target: -0.072, output: -0.047, loss: 0.001

i: 26, target: -0.094, output: -0.051, loss: 0.002

i: 27, target: -0.070, output: -0.052, loss: 0.000

i: 28, target: -0.131, output: -0.052, loss: 0.006

i: 29, target: -0.080, output: -0.051, loss: 0.001
```

```
i: 30, target: -0.061, output: -0.050, loss: 0.000
i: 31, target: -0.087, output: -0.051, loss: 0.001
i: 32, target: -0.057, output: -0.051, loss: 0.000
i: 33, target: -0.108, output: -0.049, loss: 0.003
i: 34, target: -0.084, output: -0.047, loss: 0.001
i: 35, target: -0.114, output: -0.051, loss: 0.004
i: 36, target: -0.016, output: -0.051, loss: 0.001
i: 37, target: -0.097, output: -0.052, loss: 0.002
i: 38, target: -0.054, output: -0.047, loss: 0.000
i: 39, target: -0.055, output: -0.049, loss: 0.000
i: 40, target: -0.234, output: -0.051, loss: 0.034
i: 41, target: -0.062, output: -0.052, loss: 0.000
i: 42, target: -0.058, output: -0.048, loss: 0.000
i: 43, target: -0.133, output: -0.049, loss: 0.007
i: 44, target: -0.158, output: -0.048, loss: 0.012
i: 45, target: 0.074, output: -0.048, loss: 0.015
i: 46, target: -0.048, output: -0.050, loss: 0.000
i: 47, target: -0.104, output: -0.051, loss: 0.003
i: 48, target: -0.070, output: -0.051, loss: 0.000
i: 49, target: -0.123, output: -0.051, loss: 0.005
i: 50, target: -0.018, output: -0.048, loss: 0.001
i: 51, target: -0.063, output: -0.050, loss: 0.000
i: 52, target: -0.067, output: -0.048, loss: 0.000
i: 53, target: -0.141, output: -0.052, loss: 0.008
```

```
i: 54, target: -0.061, output: -0.051, loss: 0.000
i: 55, target: -0.124, output: -0.052, loss: 0.005
i: 56, target: -0.028, output: -0.048, loss: 0.000
i: 57, target: 0.947, output: -0.050, loss: 0.994
i: 58, target: -0.130, output: -0.051, loss: 0.006
i: 59, target: -0.072, output: -0.048, loss: 0.001
i: 60, target: -0.177, output: -0.052, loss: 0.016
i: 61, target: -0.034, output: -0.051, loss: 0.000
i: 62, target: -0.067, output: -0.048, loss: 0.000
i: 63, target: -0.073, output: -0.050, loss: 0.001
i: 64, target: -0.198, output: -0.052, loss: 0.021
i: 65, target: -0.108, output: -0.050, loss: 0.003
i: 66, target: -0.095, output: -0.051, loss: 0.002
i: 67, target: 0.049, output: -0.048, loss: 0.009
i: 68, target: -0.069, output: -0.048, loss: 0.000
i: 69, target: -0.070, output: -0.048, loss: 0.000
i: 70, target: -0.122, output: -0.052, loss: 0.005
i: 71, target: -0.120, output: -0.049, loss: 0.005
i: 72, target: 0.066, output: -0.051, loss: 0.014
i: 73, target: -0.023, output: -0.049, loss: 0.001
i: 74, target: -0.109, output: -0.047, loss: 0.004
i: 75, target: -0.051, output: -0.049, loss: 0.000
i: 76, target: 0.138, output: -0.052, loss: 0.036
i: 77, target: -0.136, output: -0.049, loss: 0.008
```

```
i: 78, target: -0.070, output: -0.052, loss: 0.000
i: 79, target: -0.044, output: -0.052, loss: 0.000
i: 80, target: -0.075, output: -0.052, loss: 0.001
i: 81, target: -0.098, output: -0.051, loss: 0.002
i: 82, target: -0.123, output: -0.049, loss: 0.006
i: 83, target: -0.145, output: -0.049, loss: 0.009
i: 84, target: -0.101, output: -0.052, loss: 0.002
i: 85, target: -0.079, output: -0.051, loss: 0.001
i: 86, target: -0.029, output: -0.049, loss: 0.000
i: 87, target: 0.931, output: -0.047, loss: 0.957
i: 88, target: -0.100, output: -0.051, loss: 0.002
i: 89, target: -0.039, output: -0.048, loss: 0.000
i: 90, target: -0.065, output: -0.051, loss: 0.000
i: 91, target: -0.048, output: -0.051, loss: 0.000
i: 92, target: -0.037, output: -0.049, loss: 0.000
i: 93, target: 0.889, output: -0.049, loss: 0.880
i: 94, target: -0.054, output: -0.052, loss: 0.000
i: 95, target: -0.204, output: -0.052, loss: 0.023
i: 96, target: -0.068, output: -0.048, loss: 0.000
i: 97, target: -0.087, output: -0.052, loss: 0.001
i: 98, target: 0.765, output: -0.048, loss: 0.660
i: 99, target: -0.189, output: -0.048, loss: 0.020
i: 100, target: -0.182, output: -0.049, loss: 0.018
i: 101, target: -0.124, output: -0.049, loss: 0.006
```

```
i: 102, target: -0.098, output: -0.051, loss: 0.002
i: 103, target: -0.177, output: -0.051, loss: 0.016
i: 104, target: -0.086, output: -0.049, loss: 0.001
i: 105, target: -0.091, output: -0.050, loss: 0.002
i: 106, target: -0.079, output: -0.049, loss: 0.001
i: 107, target: -0.124, output: -0.051, loss: 0.005
i: 108, target: -0.095, output: -0.048, loss: 0.002
i: 109, target: -0.133, output: -0.049, loss: 0.007
i: 110, target: 0.043, output: -0.048, loss: 0.008
i: 111, target: -0.053, output: -0.052, loss: 0.000
i: 112, target: -0.065, output: -0.052, loss: 0.000
i: 113, target: -0.093, output: -0.051, loss: 0.002
i: 114, target: -0.223, output: -0.052, loss: 0.029
i: 115, target: -0.070, output: -0.048, loss: 0.000
i: 116, target: -0.121, output: -0.047, loss: 0.005
i: 117, target: -0.189, output: -0.052, loss: 0.019
i: 118, target: -0.150, output: -0.049, loss: 0.010
i: 119, target: -0.185, output: -0.052, loss: 0.018
i: 120, target: -0.195, output: -0.052, loss: 0.021
i: 121, target: -0.151, output: -0.051, loss: 0.010
i: 122, target: -0.063, output: -0.048, loss: 0.000
i: 123, target: -0.056, output: -0.048, loss: 0.000
i: 124, target: 0.031, output: -0.047, loss: 0.006
i: 125, target: -0.107, output: -0.052, loss: 0.003
```

```
i: 126, target: -0.083, output: -0.048, loss: 0.001
i: 127, target: -0.130, output: -0.051, loss: 0.006
i: 128, target: -0.097, output: -0.050, loss: 0.002
i: 129, target: -0.119, output: -0.052, loss: 0.004
i: 130, target: -0.165, output: -0.051, loss: 0.013
i: 131, target: 0.807, output: -0.049, loss: 0.733
i: 132, target: -0.214, output: -0.052, loss: 0.026
i: 133, target: -0.075, output: -0.051, loss: 0.001
i: 134, target: -0.031, output: -0.048, loss: 0.000
i: 135, target: -0.066, output: -0.049, loss: 0.000
i: 136, target: -0.053, output: -0.049, loss: 0.000
i: 137, target: -0.074, output: -0.049, loss: 0.001
i: 138, target: -0.042, output: -0.048, loss: 0.000
i: 139, target: -0.074, output: -0.052, loss: 0.000
i: 140, target: 0.070, output: -0.048, loss: 0.014
i: 141, target: -0.062, output: -0.047, loss: 0.000
i: 142, target: -0.108, output: -0.048, loss: 0.004
i: 143, target: -0.089, output: -0.051, loss: 0.001
i: 144, target: -0.048, output: -0.047, loss: 0.000
i: 145, target: -0.150, output: -0.052, loss: 0.010
i: 146, target: 0.970, output: -0.050, loss: 1.041
i: 147, target: -0.094, output: -0.051, loss: 0.002
i: 148, target: -0.089, output: -0.048, loss: 0.002
i: 149, target: -0.176, output: -0.051, loss: 0.016
```

```
i: 150, target: -0.152, output: -0.048, loss: 0.011
i: 151, target: -0.060, output: -0.050, loss: 0.000
i: 152, target: 0.069, output: -0.048, loss: 0.014
i: 153, target: 0.923, output: -0.048, loss: 0.942
i: 154, target: -0.132, output: -0.048, loss: 0.007
i: 155, target: -0.052, output: -0.050, loss: 0.000
i: 156, target: -0.070, output: -0.050, loss: 0.000
i: 157, target: -0.055, output: -0.049, loss: 0.000
i: 158, target: 0.953, output: -0.051, loss: 1.008
i: 159, target: 0.921, output: -0.048, loss: 0.937
i: 160, target: -0.055, output: -0.052, loss: 0.000
i: 161, target: 0.057, output: -0.050, loss: 0.011
i: 162, target: -0.136, output: -0.048, loss: 0.008
i: 163, target: -0.055, output: -0.051, loss: 0.000
i: 164, target: -0.106, output: -0.050, loss: 0.003
i: 165, target: -0.064, output: -0.052, loss: 0.000
i: 166, target: -0.170, output: -0.049, loss: 0.015
i: 167, target: -0.150, output: -0.052, loss: 0.010
i: 168, target: -0.089, output: -0.051, loss: 0.001
i: 169, target: -0.049, output: -0.051, loss: 0.000
i: 170, target: -0.154, output: -0.048, loss: 0.011
i: 171, target: -0.195, output: -0.052, loss: 0.021
i: 172, target: -0.091, output: -0.048, loss: 0.002
i: 173, target: -0.091, output: -0.051, loss: 0.002
```

```
i: 174, target: -0.036, output: -0.050, loss: 0.000
i: 175, target: -0.127, output: -0.048, loss: 0.006
i: 176, target: -0.178, output: -0.052, loss: 0.016
i: 177, target: -0.132, output: -0.052, loss: 0.006
i: 178, target: -0.158, output: -0.048, loss: 0.012
i: 179, target: -0.048, output: -0.052, loss: 0.000
i: 180, target: -0.151, output: -0.051, loss: 0.010
i: 181, target: -0.050, output: -0.049, loss: 0.000
i: 182, target: 0.103, output: -0.049, loss: 0.023
i: 183, target: -0.136, output: -0.047, loss: 0.008
i: 184, target: -0.103, output: -0.052, loss: 0.003
i: 185, target: -0.103, output: -0.052, loss: 0.003
i: 186, target: -0.099, output: -0.051, loss: 0.002
i: 187, target: 0.933, output: -0.051, loss: 0.968
i: 188, target: -0.149, output: -0.051, loss: 0.010
i: 189, target: -0.057, output: -0.052, loss: 0.000
i: 190, target: 0.880, output: -0.048, loss: 0.860
i: 191, target: -0.076, output: -0.051, loss: 0.001
i: 192, target: -0.060, output: -0.051, loss: 0.000
i: 193, target: -0.182, output: -0.052, loss: 0.017
i: 194, target: -0.055, output: -0.051, loss: 0.000
i: 195, target: -0.085, output: -0.052, loss: 0.001
i: 196, target: -0.037, output: -0.051, loss: 0.000
i: 197, target: -0.069, output: -0.048, loss: 0.000
```

```
i: 198, target: -0.215, output: -0.052, loss: 0.027
i: 199, target: 0.944, output: -0.050, loss: 0.989
i: 200, target: -0.103, output: -0.049, loss: 0.003
i: 201, target: -0.203, output: -0.052, loss: 0.023
i: 202, target: -0.150, output: -0.051, loss: 0.010
i: 203, target: 0.919, output: -0.047, loss: 0.934
i: 204, target: -0.166, output: -0.047, loss: 0.014
i: 205, target: -0.135, output: -0.050, loss: 0.007
i: 206, target: -0.111, output: -0.051, loss: 0.004
i: 207, target: -0.143, output: -0.049, loss: 0.009
i: 208, target: -0.084, output: -0.047, loss: 0.001
i: 209, target: -0.058, output: -0.049, loss: 0.000
i: 210, target: -0.040, output: -0.052, loss: 0.000
i: 211, target: -0.127, output: -0.048, loss: 0.006
i: 212, target: -0.146, output: -0.050, loss: 0.009
i: 213, target: 0.921, output: -0.049, loss: 0.941
i: 214, target: -0.137, output: -0.052, loss: 0.007
i: 215, target: 0.885, output: -0.047, loss: 0.870
i: 216, target: -0.148, output: -0.049, loss: 0.010
i: 217, target: -0.186, output: -0.052, loss: 0.018
i: 218, target: -0.084, output: -0.052, loss: 0.001
i: 219, target: 0.880, output: -0.048, loss: 0.861
i: 220, target: -0.044, output: -0.047, loss: 0.000
i: 221, target: -0.063, output: -0.049, loss: 0.000
```

```
i: 222, target: -0.062, output: -0.047, loss: 0.000
i: 223, target: -0.051, output: -0.048, loss: 0.000
i: 224, target: -0.020, output: -0.047, loss: 0.001
i: 225, target: -0.049, output: -0.051, loss: 0.000
i: 226, target: -0.197, output: -0.052, loss: 0.021
i: 227, target: -0.210, output: -0.052, loss: 0.025
i: 228, target: -0.229, output: -0.051, loss: 0.032
i: 229, target: -0.080, output: -0.048, loss: 0.001
i: 230, target: -0.055, output: -0.050, loss: 0.000
i: 231, target: -0.181, output: -0.048, loss: 0.018
i: 232, target: 0.966, output: -0.049, loss: 1.029
i: 233, target: -0.073, output: -0.048, loss: 0.001
i: 234, target: -0.198, output: -0.052, loss: 0.021
i: 235, target: -0.033, output: -0.049, loss: 0.000
i: 236, target: 0.947, output: -0.051, loss: 0.997
i: 237, target: -0.094, output: -0.051, loss: 0.002
i: 238, target: -0.052, output: -0.049, loss: 0.000
i: 239, target: -0.162, output: -0.052, loss: 0.012
i: 240, target: -0.137, output: -0.048, loss: 0.008
i: 241, target: -0.111, output: -0.051, loss: 0.004
i: 242, target: -0.165, output: -0.048, loss: 0.013
i: 243, target: -0.054, output: -0.048, loss: 0.000
i: 244, target: -0.069, output: -0.049, loss: 0.000
i: 245, target: -0.078, output: -0.051, loss: 0.001
```

```
i: 246, target: -0.142, output: -0.052, loss: 0.008
i: 247, target: -0.143, output: -0.052, loss: 0.008
i: 248, target: -0.082, output: -0.050, loss: 0.001
i: 249, target: -0.067, output: -0.052, loss: 0.000
i: 250, target: -0.064, output: -0.048, loss: 0.000
i: 251, target: -0.055, output: -0.052, loss: 0.000
i: 252, target: -0.279, output: -0.048, loss: 0.054
i: 253, target: -0.193, output: -0.049, loss: 0.021
i: 254, target: 0.944, output: -0.048, loss: 0.984
i: 255, target: -0.164, output: -0.047, loss: 0.014
i: 256, target: -0.109, output: -0.051, loss: 0.003
i: 257, target: -0.075, output: -0.051, loss: 0.001
i: 258, target: -0.203, output: -0.049, loss: 0.024
i: 259, target: -0.135, output: -0.052, loss: 0.007
i: 260, target: -0.080, output: -0.048, loss: 0.001
i: 261, target: -0.127, output: -0.051, loss: 0.006
i: 262, target: -0.089, output: -0.049, loss: 0.002
i: 263, target: -0.038, output: -0.049, loss: 0.000
i: 264, target: -0.046, output: -0.048, loss: 0.000
i: 265, target: -0.159, output: -0.052, loss: 0.012
i: 266, target: -0.092, output: -0.050, loss: 0.002
i: 267, target: -0.110, output: -0.049, loss: 0.004
i: 268, target: 0.906, output: -0.049, loss: 0.913
i: 269, target: -0.109, output: -0.048, loss: 0.004
```

```
i: 270, target: -0.061, output: -0.049, loss: 0.000

i: 271, target: -0.058, output: -0.052, loss: 0.000

i: 272, target: -0.117, output: -0.049, loss: 0.005

i: 273, target: -0.150, output: -0.051, loss: 0.010

i: 274, target: -0.062, output: -0.050, loss: 0.000

i: 275, target: -0.207, output: -0.048, loss: 0.025

i: 276, target: -0.079, output: -0.049, loss: 0.001

i: 277, target: -0.071, output: -0.048, loss: 0.001

i: 278, target: -0.179, output: -0.051, loss: 0.017

i: 279, target: -0.021, output: -0.051, loss: 0.001

i: 280, target: -0.129, output: -0.052, loss: 0.006

i: 281, target: -0.024, output: -0.052, loss: 0.001

i: 282, target: -0.125, output: -0.050, loss: 0.006

i: 283, target: -0.041, output: -0.049, loss: 0.000

i: 284, target: -0.091, output: -0.049, loss: 0.002

i: 285, target: -0.081, output: -0.050, loss: 0.001

i: 286, target: -0.073, output: -0.052, loss: 0.000

i: 287, target: -0.076, output: -0.052, loss: 0.001

i: 288, target: -0.121, output: -0.051, loss: 0.005

i: 289, target: -0.071, output: -0.052, loss: 0.000

i: 290, target: -0.048, output: -0.052, loss: 0.000

i: 291, target: -0.070, output: -0.052, loss: 0.000

i: 292, target: -0.124, output: -0.052, loss: 0.005

i: 293, target: -0.210, output: -0.052, loss: 0.025
```

```
i: 294, target: -0.147, output: -0.047, loss: 0.010
i: 295, target: -0.116, output: -0.051, loss: 0.004
i: 296, target: -0.043, output: -0.049, loss: 0.000
i: 297, target: -0.077, output: -0.049, loss: 0.001
i: 298, target: -0.037, output: -0.050, loss: 0.000
i: 299, target: -0.206, output: -0.049, loss: 0.025
i: 300, target: -0.129, output: -0.051, loss: 0.006
i: 301, target: -0.051, output: -0.051, loss: 0.000
i: 302, target: -0.174, output: -0.052, loss: 0.015
i: 303, target: -0.114, output: -0.050, loss: 0.004
i: 304, target: -0.091, output: -0.050, loss: 0.002
i: 305, target: -0.129, output: -0.050, loss: 0.006
i: 306, target: -0.046, output: -0.052, loss: 0.000
i: 307, target: -0.121, output: -0.050, loss: 0.005
i: 308, target: 0.064, output: -0.049, loss: 0.013
i: 309, target: -0.154, output: -0.049, loss: 0.011
i: 310, target: -0.093, output: -0.048, loss: 0.002
i: 311, target: -0.125, output: -0.048, loss: 0.006
i: 312, target: -0.045, output: -0.052, loss: 0.000
i: 313, target: -0.021, output: -0.051, loss: 0.001
i: 314, target: -0.057, output: -0.051, loss: 0.000
i: 315, target: -0.066, output: -0.049, loss: 0.000
i: 316, target: -0.147, output: -0.052, loss: 0.009
i: 317, target: -0.083, output: -0.048, loss: 0.001
```

```
i: 318, target: -0.125, output: -0.051, loss: 0.005
i: 319, target: -0.223, output: -0.051, loss: 0.029
i: 320, target: -0.164, output: -0.052, loss: 0.013
i: 321, target: -0.243, output: -0.049, loss: 0.038
i: 322, target: 0.903, output: -0.050, loss: 0.909
i: 323, target: -0.093, output: -0.052, loss: 0.002
i: 324, target: -0.036, output: -0.050, loss: 0.000
i: 325, target: -0.076, output: -0.052, loss: 0.001
i: 326, target: -0.062, output: -0.052, loss: 0.000
i: 327, target: -0.115, output: -0.052, loss: 0.004
i: 328, target: -0.080, output: -0.052, loss: 0.001
i: 329, target: -0.142, output: -0.047, loss: 0.009
i: 330, target: -0.043, output: -0.050, loss: 0.000
i: 331, target: -0.100, output: -0.052, loss: 0.002
i: 332, target: -0.063, output: -0.050, loss: 0.000
i: 333, target: -0.061, output: -0.051, loss: 0.000
i: 334, target: -0.057, output: -0.052, loss: 0.000
i: 335, target: -0.038, output: -0.050, loss: 0.000
i: 336, target: -0.059, output: -0.051, loss: 0.000
i: 337, target: -0.105, output: -0.048, loss: 0.003
i: 338, target: -0.131, output: -0.050, loss: 0.007
i: 339, target: -0.088, output: -0.049, loss: 0.002
i: 340, target: -0.141, output: -0.048, loss: 0.009
i: 341, target: -0.128, output: -0.047, loss: 0.006
```

```
i: 342, target: -0.118, output: -0.047, loss: 0.005

i: 343, target: -0.063, output: -0.051, loss: 0.000

i: 344, target: -0.037, output: -0.052, loss: 0.000

i: 345, target: -0.069, output: -0.052, loss: 0.000

i: 346, target: -0.097, output: -0.051, loss: 0.002

i: 347, target: -0.096, output: -0.048, loss: 0.002

i: 348, target: -0.137, output: -0.052, loss: 0.007

i: 349, target: -0.057, output: -0.052, loss: 0.000

i: 350, target: -0.127, output: -0.052, loss: 0.006

i: 351, target: -0.043, output: -0.052, loss: 0.000

i: 352, target: -0.146, output: -0.051, loss: 0.009

i: 353, target: -0.115, output: -0.049, loss: 0.004

i: 354, target: -0.101, output: -0.048, loss: 0.003

i: 355, target: -0.114, output: -0.052, loss: 0.004

i: 356, target: -0.164, output: -0.052, loss: 0.013

i: 357, target: -0.074, output: -0.050, loss: 0.001

i: 358, target: -0.066, output: -0.052, loss: 0.000

i: 359, target: -0.059, output: -0.051, loss: 0.000

i: 360, target: -0.116, output: -0.050, loss: 0.004

i: 361, target: -0.165, output: -0.052, loss: 0.013

i: 362, target: -0.084, output: -0.050, loss: 0.001

i: 363, target: -0.069, output: -0.047, loss: 0.000

i: 364, target: -0.025, output: -0.050, loss: 0.001

i: 365, target: 0.893, output: -0.051, loss: 0.892
```

```
i: 366, target: -0.126, output: -0.051, loss: 0.006
i: 367, target: -0.078, output: -0.052, loss: 0.001
i: 368, target: -0.034, output: -0.047, loss: 0.000
i: 369, target: -0.039, output: -0.047, loss: 0.000
i: 370, target: -0.060, output: -0.048, loss: 0.000
i: 371, target: -0.157, output: -0.051, loss: 0.011
i: 372, target: -0.063, output: -0.050, loss: 0.000
i: 373, target: -0.158, output: -0.050, loss: 0.012
i: 374, target: -0.024, output: -0.047, loss: 0.001
i: 375, target: 0.004, output: -0.051, loss: 0.003
i: 376, target: -0.066, output: -0.049, loss: 0.000
i: 377, target: -0.072, output: -0.051, loss: 0.000
i: 378, target: -0.096, output: -0.048, loss: 0.002
i: 379, target: -0.064, output: -0.048, loss: 0.000
i: 380, target: -0.174, output: -0.050, loss: 0.015
i: 381, target: -0.146, output: -0.050, loss: 0.009
i: 382, target: -0.192, output: -0.052, loss: 0.020
i: 383, target: -0.142, output: -0.049, loss: 0.009
i: 384, target: -0.030, output: -0.051, loss: 0.000
i: 385, target: -0.130, output: -0.052, loss: 0.006
i: 386, target: -0.137, output: -0.048, loss: 0.008
i: 387, target: -0.210, output: -0.051, loss: 0.025
i: 388, target: -0.133, output: -0.050, loss: 0.007
i: 389, target: -0.077, output: -0.050, loss: 0.001
```

```
i: 390, target: 0.975, output: -0.050, loss: 1.052

i: 391, target: -0.064, output: -0.049, loss: 0.000

i: 392, target: 0.081, output: -0.050, loss: 0.017

i: 393, target: 0.976, output: -0.047, loss: 1.046

i: 394, target: -0.069, output: -0.052, loss: 0.000

i: 395, target: -0.075, output: -0.048, loss: 0.001

i: 396, target: -0.190, output: -0.051, loss: 0.019

i: 397, target: -0.031, output: -0.049, loss: 0.000

i: 398, target: -0.066, output: -0.048, loss: 0.000

i: 399, target: -0.063, output: -0.052, loss: 0.000

i: 400, target: -0.022, output: -0.050, loss: 0.001

i: 401, target: -0.058, output: -0.050, loss: 0.000

i: 402, target: -0.056, output: -0.052, loss: 0.000

i: 403, target: -0.078, output: -0.047, loss: 0.001

i: 404, target: -0.119, output: -0.052, loss: 0.005

i: 405, target: -0.142, output: -0.052, loss: 0.008

i: 406, target: -0.054, output: -0.048, loss: 0.000

i: 407, target: -0.105, output: -0.052, loss: 0.003

i: 408, target: -0.165, output: -0.051, loss: 0.013

i: 409, target: -0.168, output: -0.049, loss: 0.014

i: 410, target: -0.124, output: -0.051, loss: 0.005

i: 411, target: -0.186, output: -0.049, loss: 0.019

i: 412, target: -0.132, output: -0.052, loss: 0.006

i: 413, target: 0.960, output: -0.048, loss: 1.015
```

```
i: 414, target: -0.103, output: -0.048, loss: 0.003
i: 415, target: -0.060, output: -0.052, loss: 0.000
i: 416, target: -0.023, output: -0.049, loss: 0.001
i: 417, target: -0.061, output: -0.050, loss: 0.000
i: 418, target: 0.894, output: -0.048, loss: 0.886
i: 419, target: -0.146, output: -0.048, loss: 0.010
i: 420, target: -0.043, output: -0.049, loss: 0.000
i: 421, target: -0.101, output: -0.052, loss: 0.002
i: 422, target: -0.061, output: -0.048, loss: 0.000
i: 423, target: -0.213, output: -0.049, loss: 0.027
i: 424, target: -0.013, output: -0.049, loss: 0.001
i: 425, target: -0.046, output: -0.047, loss: 0.000
i: 426, target: 0.052, output: -0.047, loss: 0.010
i: 427, target: -0.178, output: -0.048, loss: 0.017
i: 428, target: -0.133, output: -0.049, loss: 0.007
i: 429, target: -0.062, output: -0.050, loss: 0.000
i: 430, target: -0.092, output: -0.051, loss: 0.002
i: 431, target: -0.054, output: -0.050, loss: 0.000
i: 432, target: -0.150, output: -0.052, loss: 0.009
i: 433, target: -0.108, output: -0.050, loss: 0.003
i: 434, target: -0.125, output: -0.050, loss: 0.006
i: 435, target: -0.071, output: -0.052, loss: 0.000
i: 436, target: -0.107, output: -0.051, loss: 0.003
i: 437, target: -0.126, output: -0.049, loss: 0.006
```

```
i: 438, target: -0.089, output: -0.049, loss: 0.002
i: 439, target: 0.048, output: -0.048, loss: 0.009
i: 440, target: -0.102, output: -0.051, loss: 0.003
i: 441, target: -0.069, output: -0.049, loss: 0.000
i: 442, target: -0.130, output: -0.048, loss: 0.007
i: 443, target: -0.077, output: -0.050, loss: 0.001
i: 444, target: -0.055, output: -0.052, loss: 0.000
i: 445, target: -0.086, output: -0.051, loss: 0.001
i: 446, target: -0.207, output: -0.048, loss: 0.025
i: 447, target: -0.065, output: -0.050, loss: 0.000
i: 448, target: 0.049, output: -0.047, loss: 0.009
i: 449, target: -0.053, output: -0.052, loss: 0.000
i: 450, target: -0.046, output: -0.047, loss: 0.000
i: 451, target: -0.085, output: -0.050, loss: 0.001
i: 452, target: -0.204, output: -0.052, loss: 0.023
i: 453, target: -0.143, output: -0.051, loss: 0.009
i: 454, target: -0.155, output: -0.052, loss: 0.011
i: 455, target: -0.039, output: -0.052, loss: 0.000
i: 456, target: -0.136, output: -0.052, loss: 0.007
i: 457, target: -0.061, output: -0.048, loss: 0.000
i: 458, target: -0.101, output: -0.052, loss: 0.002
i: 459, target: -0.058, output: -0.051, loss: 0.000
i: 460, target: -0.120, output: -0.052, loss: 0.005
i: 461, target: -0.062, output: -0.048, loss: 0.000
```

```
i: 462, target: -0.036, output: -0.052, loss: 0.000
i: 463, target: -0.065, output: -0.052, loss: 0.000
i: 464, target: -0.099, output: -0.050, loss: 0.002
i: 465, target: 0.861, output: -0.048, loss: 0.827
i: 466, target: -0.207, output: -0.048, loss: 0.025
i: 467, target: -0.111, output: -0.050, loss: 0.004
i: 468, target: -0.128, output: -0.048, loss: 0.006
i: 469, target: -0.048, output: -0.051, loss: 0.000
i: 470, target: 0.133, output: -0.052, loss: 0.034
i: 471, target: -0.159, output: -0.052, loss: 0.012
i: 472, target: -0.128, output: -0.050, loss: 0.006
i: 473, target: -0.042, output: -0.052, loss: 0.000
i: 474, target: -0.087, output: -0.048, loss: 0.001
i: 475, target: -0.100, output: -0.049, loss: 0.003
i: 476, target: -0.112, output: -0.051, loss: 0.004
i: 477, target: -0.150, output: -0.051, loss: 0.010
i: 478, target: -0.061, output: -0.048, loss: 0.000
i: 479, target: -0.212, output: -0.052, loss: 0.026
i: 480, target: -0.129, output: -0.048, loss: 0.007
i: 481, target: -0.041, output: -0.050, loss: 0.000
i: 482, target: -0.050, output: -0.052, loss: 0.000
i: 483, target: -0.140, output: -0.051, loss: 0.008
i: 484, target: -0.051, output: -0.048, loss: 0.000
i: 485, target: -0.181, output: -0.049, loss: 0.017
```

```
i: 486, target: -0.210, output: -0.052, loss: 0.025
i: 487, target: -0.165, output: -0.050, loss: 0.013
i: 488, target: -0.131, output: -0.050, loss: 0.007
i: 489, target: -0.164, output: -0.052, loss: 0.013
i: 490, target: -0.107, output: -0.049, loss: 0.003
i: 491, target: -0.205, output: -0.051, loss: 0.024
i: 492, target: -0.115, output: -0.051, loss: 0.004
i: 493, target: -0.129, output: -0.052, loss: 0.006
i: 494, target: -0.061, output: -0.049, loss: 0.000
i: 495, target: 0.062, output: -0.052, loss: 0.013
i: 496, target: -0.041, output: -0.048, loss: 0.000
i: 497, target: -0.048, output: -0.052, loss: 0.000
i: 498, target: -0.058, output: -0.049, loss: 0.000
i: 499, target: -0.064, output: -0.052, loss: 0.000
i: 500, target: -0.052, output: -0.050, loss: 0.000
i: 501, target: -0.168, output: -0.048, loss: 0.014
i: 502, target: -0.085, output: -0.052, loss: 0.001
i: 503, target: -0.152, output: -0.049, loss: 0.010
i: 504, target: -0.030, output: -0.052, loss: 0.000
i: 505, target: -0.073, output: -0.052, loss: 0.000
i: 506, target: -0.214, output: -0.048, loss: 0.028
i: 507, target: -0.075, output: -0.048, loss: 0.001
i: 508, target: -0.123, output: -0.052, loss: 0.005
i: 509, target: -0.116, output: -0.052, loss: 0.004
```

```
i: 510, target: -0.122, output: -0.051, loss: 0.005
i: 511, target: -0.103, output: -0.051, loss: 0.003
i: 512, target: -0.050, output: -0.052, loss: 0.000
i: 513, target: -0.128, output: -0.048, loss: 0.006
i: 514, target: -0.113, output: -0.048, loss: 0.004
i: 515, target: -0.149, output: -0.051, loss: 0.010
i: 516, target: -0.098, output: -0.049, loss: 0.002
i: 517, target: -0.084, output: -0.048, loss: 0.001
i: 518, target: -0.016, output: -0.048, loss: 0.001
i: 519, target: -0.078, output: -0.052, loss: 0.001
i: 520, target: -0.093, output: -0.050, loss: 0.002
i: 521, target: -0.055, output: -0.048, loss: 0.000
i: 522, target: 0.037, output: -0.051, loss: 0.008
i: 523, target: 0.047, output: -0.048, loss: 0.009
i: 524, target: -0.147, output: -0.047, loss: 0.010
i: 525, target: -0.123, output: -0.049, loss: 0.005
i: 526, target: -0.098, output: -0.048, loss: 0.002
i: 527, target: -0.063, output: -0.050, loss: 0.000
i: 528, target: -0.087, output: -0.052, loss: 0.001
i: 529, target: 0.939, output: -0.049, loss: 0.975
i: 530, target: -0.159, output: -0.051, loss: 0.012
i: 531, target: -0.111, output: -0.049, loss: 0.004
i: 532, target: -0.169, output: -0.048, loss: 0.015
i: 533, target: -0.219, output: -0.048, loss: 0.029
```

```
i: 534, target: -0.039, output: -0.050, loss: 0.000
i: 535, target: 0.964, output: -0.048, loss: 1.025
i: 536, target: -0.061, output: -0.048, loss: 0.000
i: 537, target: -0.157, output: -0.052, loss: 0.011
i: 538, target: -0.208, output: -0.051, loss: 0.025
i: 539, target: -0.160, output: -0.052, loss: 0.012
i: 540, target: -0.148, output: -0.052, loss: 0.009
i: 541, target: -0.202, output: -0.052, loss: 0.022
i: 542, target: -0.071, output: -0.049, loss: 0.001
i: 543, target: 0.904, output: -0.049, loss: 0.908
i: 544, target: -0.116, output: -0.051, loss: 0.004
i: 545, target: -0.148, output: -0.052, loss: 0.009
i: 546, target: -0.105, output: -0.051, loss: 0.003
i: 547, target: -0.151, output: -0.048, loss: 0.011
i: 548, target: -0.049, output: -0.050, loss: 0.000
i: 549, target: 0.070, output: -0.049, loss: 0.014
i: 550, target: -0.118, output: -0.052, loss: 0.004
i: 551, target: 0.948, output: -0.049, loss: 0.993
i: 552, target: -0.064, output: -0.052, loss: 0.000
i: 553, target: -0.171, output: -0.050, loss: 0.015
i: 554, target: -0.061, output: -0.049, loss: 0.000
i: 555, target: -0.198, output: -0.050, loss: 0.022
i: 556, target: -0.054, output: -0.048, loss: 0.000
i: 557, target: -0.108, output: -0.050, loss: 0.003
```

```
i: 558, target: -0.099, output: -0.049, loss: 0.003
i: 559, target: -0.075, output: -0.050, loss: 0.001
i: 560, target: -0.179, output: -0.047, loss: 0.017
i: 561, target: -0.132, output: -0.051, loss: 0.007
i: 562, target: -0.071, output: -0.052, loss: 0.000
i: 563, target: -0.115, output: -0.051, loss: 0.004
i: 564, target: -0.171, output: -0.048, loss: 0.015
i: 565, target: -0.040, output: -0.048, loss: 0.000
i: 566, target: -0.198, output: -0.050, loss: 0.022
i: 567, target: -0.086, output: -0.052, loss: 0.001
i: 568, target: -0.150, output: -0.052, loss: 0.010
i: 569, target: 0.079, output: -0.047, loss: 0.016
i: 570, target: -0.071, output: -0.052, loss: 0.000
i: 571, target: -0.053, output: -0.052, loss: 0.000
i: 572, target: -0.055, output: -0.051, loss: 0.000
i: 573, target: -0.050, output: -0.049, loss: 0.000
i: 574, target: -0.088, output: -0.049, loss: 0.002
i: 575, target: -0.032, output: -0.050, loss: 0.000
i: 576, target: -0.052, output: -0.051, loss: 0.000
i: 577, target: 0.953, output: -0.048, loss: 1.001
i: 578, target: -0.147, output: -0.049, loss: 0.010
i: 579, target: -0.075, output: -0.049, loss: 0.001
i: 580, target: -0.177, output: -0.052, loss: 0.015
i: 581, target: -0.119, output: -0.050, loss: 0.005
```

```
i: 582, target: -0.171, output: -0.050, loss: 0.015
i: 583, target: -0.152, output: -0.050, loss: 0.010
i: 584, target: -0.101, output: -0.052, loss: 0.002
i: 585, target: -0.138, output: -0.049, loss: 0.008
i: 586, target: -0.082, output: -0.052, loss: 0.001
i: 587, target: -0.173, output: -0.050, loss: 0.015
i: 588, target: -0.112, output: -0.051, loss: 0.004
i: 589, target: -0.045, output: -0.050, loss: 0.000
i: 590, target: -0.110, output: -0.052, loss: 0.003
i: 591, target: -0.082, output: -0.048, loss: 0.001
i: 592, target: -0.033, output: -0.048, loss: 0.000
i: 593, target: -0.085, output: -0.050, loss: 0.001
i: 594, target: -0.166, output: -0.050, loss: 0.013
i: 595, target: -0.047, output: -0.048, loss: 0.000
i: 596, target: -0.182, output: -0.051, loss: 0.017
i: 597, target: -0.081, output: -0.048, loss: 0.001
i: 598, target: -0.021, output: -0.048, loss: 0.001
i: 599, target: -0.145, output: -0.049, loss: 0.009
i: 600, target: -0.052, output: -0.052, loss: 0.000
i: 601, target: -0.075, output: -0.049, loss: 0.001
i: 602, target: -0.127, output: -0.052, loss: 0.006
i: 603, target: -0.147, output: -0.048, loss: 0.010
i: 604, target: -0.101, output: -0.052, loss: 0.002
i: 605, target: -0.139, output: -0.049, loss: 0.008
```

```
i: 606, target: -0.057, output: -0.051, loss: 0.000
i: 607, target: -0.122, output: -0.050, loss: 0.005
i: 608, target: -0.113, output: -0.051, loss: 0.004
i: 609, target: -0.120, output: -0.052, loss: 0.005
i: 610, target: -0.097, output: -0.050, loss: 0.002
i: 611, target: -0.137, output: -0.051, loss: 0.007
i: 612, target: -0.066, output: -0.052, loss: 0.000
i: 613, target: -0.027, output: -0.049, loss: 0.000
i: 614, target: -0.095, output: -0.052, loss: 0.002
i: 615, target: -0.071, output: -0.048, loss: 0.001
i: 616, target: -0.022, output: -0.052, loss: 0.001
i: 617, target: -0.141, output: -0.049, loss: 0.008
i: 618, target: -0.091, output: -0.051, loss: 0.002
i: 619, target: -0.213, output: -0.049, loss: 0.027
i: 620, target: -0.037, output: -0.051, loss: 0.000
i: 621, target: -0.095, output: -0.048, loss: 0.002
i: 622, target: 0.035, output: -0.047, loss: 0.007
i: 623, target: -0.137, output: -0.050, loss: 0.008
i: 624, target: -0.110, output: -0.051, loss: 0.004
i: 625, target: -0.206, output: -0.052, loss: 0.024
i: 626, target: -0.101, output: -0.052, loss: 0.002
i: 627, target: -0.120, output: -0.052, loss: 0.005
i: 628, target: -0.118, output: -0.050, loss: 0.005
i: 629, target: -0.085, output: -0.049, loss: 0.001
```

```
i: 630, target: -0.068, output: -0.052, loss: 0.000
i: 631, target: -0.079, output: -0.051, loss: 0.001
i: 632, target: -0.055, output: -0.048, loss: 0.000
i: 633, target: -0.097, output: -0.049, loss: 0.002
i: 634, target: -0.093, output: -0.052, loss: 0.002
i: 635, target: -0.121, output: -0.052, loss: 0.005
i: 636, target: -0.057, output: -0.049, loss: 0.000
i: 637, target: -0.054, output: -0.050, loss: 0.000
i: 638, target: -0.077, output: -0.048, loss: 0.001
i: 639, target: -0.165, output: -0.049, loss: 0.013
i: 640, target: -0.089, output: -0.051, loss: 0.002
i: 641, target: 0.026, output: -0.048, loss: 0.006
i: 642, target: -0.131, output: -0.050, loss: 0.007
i: 643, target: -0.074, output: -0.051, loss: 0.001
i: 644, target: -0.075, output: -0.050, loss: 0.001
i: 645, target: -0.122, output: -0.051, loss: 0.005
i: 646, target: -0.084, output: -0.049, loss: 0.001
i: 647, target: -0.066, output: -0.050, loss: 0.000
i: 648, target: -0.140, output: -0.048, loss: 0.008
i: 649, target: 0.926, output: -0.048, loss: 0.948
i: 650, target: -0.017, output: -0.049, loss: 0.001
i: 651, target: -0.134, output: -0.049, loss: 0.007
i: 652, target: 0.033, output: -0.048, loss: 0.007
i: 653, target: -0.097, output: -0.052, loss: 0.002
```

```
i: 654, target: -0.183, output: -0.051, loss: 0.017
i: 655, target: -0.038, output: -0.048, loss: 0.000
i: 656, target: -0.082, output: -0.047, loss: 0.001
i: 657, target: -0.047, output: -0.052, loss: 0.000
i: 658, target: -0.183, output: -0.049, loss: 0.018
i: 659, target: -0.192, output: -0.052, loss: 0.020
i: 660, target: -0.054, output: -0.050, loss: 0.000
i: 661, target: -0.106, output: -0.052, loss: 0.003
i: 662, target: -0.131, output: -0.051, loss: 0.006
i: 663, target: -0.093, output: -0.048, loss: 0.002
i: 664, target: 0.036, output: -0.049, loss: 0.007
i: 665, target: -0.291, output: -0.050, loss: 0.058
i: 666, target: -0.067, output: -0.048, loss: 0.000
i: 667, target: 0.892, output: -0.050, loss: 0.888
i: 668, target: -0.097, output: -0.050, loss: 0.002
i: 669, target: -0.120, output: -0.052, loss: 0.005
i: 670, target: -0.077, output: -0.049, loss: 0.001
i: 671, target: -0.052, output: -0.052, loss: 0.000
i: 672, target: -0.069, output: -0.049, loss: 0.000
i: 673, target: -0.114, output: -0.048, loss: 0.004
i: 674, target: -0.154, output: -0.052, loss: 0.010
i: 675, target: -0.056, output: -0.049, loss: 0.000
i: 676, target: -0.147, output: -0.048, loss: 0.010
i: 677, target: -0.086, output: -0.049, loss: 0.001
```

```
i: 678, target: -0.151, output: -0.050, loss: 0.010
i: 679, target: -0.134, output: -0.051, loss: 0.007
i: 680, target: -0.039, output: -0.052, loss: 0.000
i: 681, target: -0.123, output: -0.047, loss: 0.006
i: 682, target: -0.144, output: -0.050, loss: 0.009
i: 683, target: -0.180, output: -0.052, loss: 0.016
i: 684, target: -0.031, output: -0.049, loss: 0.000
i: 685, target: 0.898, output: -0.050, loss: 0.900
i: 686, target: -0.199, output: -0.052, loss: 0.022
i: 687, target: -0.158, output: -0.051, loss: 0.012
i: 688, target: -0.060, output: -0.052, loss: 0.000
i: 689, target: -0.179, output: -0.051, loss: 0.016
i: 690, target: -0.029, output: -0.052, loss: 0.001
i: 691, target: -0.107, output: -0.051, loss: 0.003
i: 692, target: -0.079, output: -0.049, loss: 0.001
i: 693, target: 0.963, output: -0.047, loss: 1.019
i: 694, target: -0.050, output: -0.050, loss: 0.000
i: 695, target: -0.073, output: -0.051, loss: 0.000
i: 696, target: -0.135, output: -0.049, loss: 0.007
i: 697, target: -0.052, output: -0.049, loss: 0.000
i: 698, target: -0.137, output: -0.052, loss: 0.007
i: 699, target: -0.068, output: -0.050, loss: 0.000
i: 700, target: -0.054, output: -0.052, loss: 0.000
i: 701, target: -0.164, output: -0.049, loss: 0.013
```

i: 702, target: -0.182, output: -0.052, loss: 0.017

i: 703, target: -0.079, output: -0.052, loss: 0.001

i: 704, target: -0.109, output: -0.048, loss: 0.004

i: 705, target: -0.131, output: -0.048, loss: 0.007

i: 706, target: -0.093, output: -0.051, loss: 0.002

i: 707, target: -0.052, output: -0.050, loss: 0.000

i: 708, target: -0.105, output: -0.051, loss: 0.003

i: 709, target: -0.070, output: -0.052, loss: 0.000

i: 710, target: -0.027, output: -0.049, loss: 0.000

i: 711, target: -0.121, output: -0.051, loss: 0.005

i: 712, target: -0.060, output: -0.049, loss: 0.000

i: 713, target: -0.115, output: -0.052, loss: 0.004

i: 714, target: -0.150, output: -0.051, loss: 0.010

i: 715, target: -0.064, output: -0.048, loss: 0.000

i: 716, target: -0.079, output: -0.052, loss: 0.001

i: 717, target: -0.145, output: -0.052, loss: 0.009

i: 718, target: -0.074, output: -0.047, loss: 0.001

i: 719, target: -0.045, output: -0.051, loss: 0.000

i: 720, target: -0.091, output: -0.051, loss: 0.002

i: 721, target: -0.102, output: -0.052, loss: 0.002

i: 722, target: -0.132, output: -0.051, loss: 0.007

i: 723, target: -0.091, output: -0.049, loss: 0.002

i: 724, target: -0.117, output: -0.048, loss: 0.005

i: 725, target: -0.063, output: -0.049, loss: 0.000

```
i: 726, target: -0.143, output: -0.047, loss: 0.009
i: 727, target: -0.087, output: -0.049, loss: 0.001
i: 728, target: -0.050, output: -0.052, loss: 0.000
i: 729, target: -0.133, output: -0.051, loss: 0.007
i: 730, target: -0.171, output: -0.048, loss: 0.015
i: 731, target: 0.951, output: -0.047, loss: 0.996
i: 732, target: -0.128, output: -0.050, loss: 0.006
i: 733, target: -0.099, output: -0.048, loss: 0.003
i: 734, target: -0.070, output: -0.052, loss: 0.000
i: 735, target: -0.061, output: -0.051, loss: 0.000
i: 736, target: -0.082, output: -0.049, loss: 0.001
i: 737, target: -0.104, output: -0.050, loss: 0.003
i: 738, target: -0.071, output: -0.052, loss: 0.000
i: 739, target: -0.046, output: -0.050, loss: 0.000
i: 740, target: -0.113, output: -0.052, loss: 0.004
i: 741, target: -0.036, output: -0.050, loss: 0.000
i: 742, target: -0.113, output: -0.049, loss: 0.004
i: 743, target: 0.941, output: -0.051, loss: 0.985
i: 744, target: -0.108, output: -0.048, loss: 0.004
i: 745, target: -0.161, output: -0.048, loss: 0.013
i: 746, target: -0.112, output: -0.050, loss: 0.004
i: 747, target: -0.076, output: -0.047, loss: 0.001
i: 748, target: -0.087, output: -0.048, loss: 0.001
i: 749, target: -0.109, output: -0.051, loss: 0.003
```

```
i: 750, target: -0.066, output: -0.048, loss: 0.000
i: 751, target: -0.127, output: -0.048, loss: 0.006
i: 752, target: -0.084, output: -0.050, loss: 0.001
i: 753, target: -0.141, output: -0.047, loss: 0.009
i: 754, target: -0.027, output: -0.047, loss: 0.000
i: 755, target: -0.181, output: -0.050, loss: 0.017
i: 756, target: -0.221, output: -0.048, loss: 0.030
i: 757, target: -0.191, output: -0.052, loss: 0.019
i: 758, target: -0.099, output: -0.047, loss: 0.003
i: 759, target: -0.232, output: -0.049, loss: 0.033
i: 760, target: -0.078, output: -0.052, loss: 0.001
i: 761, target: -0.119, output: -0.048, loss: 0.005
i: 762, target: 0.028, output: -0.048, loss: 0.006
i: 763, target: -0.045, output: -0.050, loss: 0.000
i: 764, target: -0.236, output: -0.048, loss: 0.035
i: 765, target: -0.058, output: -0.049, loss: 0.000
i: 766, target: -0.068, output: -0.052, loss: 0.000
i: 767, target: -0.075, output: -0.051, loss: 0.001
i: 768, target: -0.073, output: -0.051, loss: 0.000
i: 769, target: -0.092, output: -0.047, loss: 0.002
i: 770, target: -0.073, output: -0.052, loss: 0.000
i: 771, target: -0.146, output: -0.049, loss: 0.009
i: 772, target: -0.163, output: -0.049, loss: 0.013
i: 773, target: -0.057, output: -0.047, loss: 0.000
```

```
i: 774, target: -0.117, output: -0.047, loss: 0.005

i: 775, target: -0.042, output: -0.049, loss: 0.000

i: 776, target: -0.068, output: -0.051, loss: 0.000

i: 777, target: 0.036, output: -0.051, loss: 0.008

i: 778, target: -0.172, output: -0.051, loss: 0.015

i: 779, target: -0.096, output: -0.052, loss: 0.002

i: 780, target: -0.215, output: -0.048, loss: 0.028

i: 781, target: -0.034, output: -0.047, loss: 0.000

i: 782, target: 0.042, output: -0.050, loss: 0.008

i: 783, target: -0.001, output: -0.048, loss: 0.002

i: 784, target: -0.071, output: -0.051, loss: 0.000

i: 785, target: -0.129, output: -0.048, loss: 0.006

i: 786, target: -0.138, output: -0.052, loss: 0.007

i: 787, target: 0.996, output: -0.051, loss: 1.096

i: 788, target: -0.262, output: -0.048, loss: 0.046

i: 789, target: -0.091, output: -0.050, loss: 0.002

i: 790, target: -0.129, output: -0.051, loss: 0.006

i: 791, target: -0.087, output: -0.051, loss: 0.001

i: 792, target: -0.040, output: -0.048, loss: 0.000

i: 793, target: -0.063, output: -0.052, loss: 0.000

i: 794, target: -0.129, output: -0.051, loss: 0.006

i: 795, target: 0.045, output: -0.051, loss: 0.009

i: 796, target: -0.125, output: -0.052, loss: 0.005

i: 797, target: -0.076, output: -0.050, loss: 0.001
```

```
i: 798, target: -0.065, output: -0.052, loss: 0.000
i: 799, target: -0.042, output: -0.049, loss: 0.000
i: 800, target: -0.070, output: -0.049, loss: 0.000
i: 801, target: -0.058, output: -0.050, loss: 0.000
i: 802, target: -0.132, output: -0.052, loss: 0.006
i: 803, target: -0.255, output: -0.050, loss: 0.042
i: 804, target: -0.055, output: -0.048, loss: 0.000
i: 805, target: -0.142, output: -0.048, loss: 0.009
i: 806, target: -0.131, output: -0.051, loss: 0.006
i: 807, target: -0.140, output: -0.051, loss: 0.008
i: 808, target: -0.040, output: -0.052, loss: 0.000
i: 809, target: -0.090, output: -0.052, loss: 0.001
i: 810, target: -0.055, output: -0.048, loss: 0.000
i: 811, target: -0.101, output: -0.049, loss: 0.003
i: 812, target: -0.118, output: -0.048, loss: 0.005
i: 813, target: -0.166, output: -0.051, loss: 0.013
i: 814, target: -0.102, output: -0.049, loss: 0.003
i: 815, target: -0.059, output: -0.051, loss: 0.000
i: 816, target: -0.130, output: -0.051, loss: 0.006
i: 817, target: 0.957, output: -0.049, loss: 1.012
i: 818, target: -0.041, output: -0.052, loss: 0.000
i: 819, target: 0.976, output: -0.051, loss: 1.054
i: 820, target: -0.100, output: -0.051, loss: 0.002
i: 821, target: 0.994, output: -0.048, loss: 1.086
```

```
i: 822, target: -0.062, output: -0.052, loss: 0.000

i: 823, target: -0.057, output: -0.051, loss: 0.000

i: 824, target: -0.056, output: -0.052, loss: 0.000

i: 825, target: -0.096, output: -0.050, loss: 0.002

i: 826, target: -0.081, output: -0.048, loss: 0.001

i: 827, target: -0.048, output: -0.050, loss: 0.000

i: 828, target: -0.179, output: -0.052, loss: 0.016

i: 829, target: -0.166, output: -0.052, loss: 0.013

i: 830, target: -0.068, output: -0.050, loss: 0.000

i: 831, target: -0.122, output: -0.049, loss: 0.005

i: 832, target: -0.039, output: -0.050, loss: 0.000

i: 833, target: -0.081, output: -0.052, loss: 0.001

i: 834, target: -0.122, output: -0.052, loss: 0.005

i: 835, target: -0.125, output: -0.049, loss: 0.006

i: 836, target: -0.037, output: -0.050, loss: 0.000

i: 837, target: -0.218, output: -0.048, loss: 0.029

i: 838, target: -0.112, output: -0.047, loss: 0.004

i: 839, target: -0.113, output: -0.052, loss: 0.004

i: 840, target: 0.960, output: -0.048, loss: 1.015

i: 841, target: -0.118, output: -0.048, loss: 0.005

i: 842, target: -0.197, output: -0.048, loss: 0.022

i: 843, target: -0.176, output: -0.049, loss: 0.016

i: 844, target: -0.132, output: -0.050, loss: 0.007

i: 845, target: -0.069, output: -0.048, loss: 0.000
```

```
i: 846, target: -0.170, output: -0.052, loss: 0.014
i: 847, target: -0.175, output: -0.051, loss: 0.015
i: 848, target: 0.007, output: -0.049, loss: 0.003
i: 849, target: -0.141, output: -0.051, loss: 0.008
i: 850, target: -0.148, output: -0.048, loss: 0.010
i: 851, target: -0.033, output: -0.052, loss: 0.000
i: 852, target: -0.202, output: -0.049, loss: 0.023
i: 853, target: -0.156, output: -0.047, loss: 0.012
i: 854, target: 0.932, output: -0.048, loss: 0.960
i: 855, target: -0.115, output: -0.048, loss: 0.004
i: 856, target: -0.150, output: -0.048, loss: 0.010
i: 857, target: -0.064, output: -0.048, loss: 0.000
i: 858, target: -0.064, output: -0.051, loss: 0.000
i: 859, target: -0.149, output: -0.052, loss: 0.009
i: 860, target: -0.133, output: -0.050, loss: 0.007
i: 861, target: -0.080, output: -0.052, loss: 0.001
i: 862, target: -0.155, output: -0.052, loss: 0.011
i: 863, target: -0.134, output: -0.049, loss: 0.007
i: 864, target: -0.146, output: -0.050, loss: 0.009
i: 865, target: -0.113, output: -0.051, loss: 0.004
i: 866, target: -0.214, output: -0.052, loss: 0.026
i: 867, target: -0.062, output: -0.047, loss: 0.000
i: 868, target: -0.185, output: -0.051, loss: 0.018
i: 869, target: -0.332, output: -0.051, loss: 0.079
```

```
i: 870, target: -0.131, output: -0.051, loss: 0.006

i: 871, target: -0.065, output: -0.052, loss: 0.000

i: 872, target: -0.029, output: -0.048, loss: 0.000

i: 873, target: -0.149, output: -0.052, loss: 0.009

i: 874, target: -0.173, output: -0.051, loss: 0.015

i: 875, target: -0.094, output: -0.052, loss: 0.002

i: 876, target: -0.171, output: -0.051, loss: 0.014

i: 877, target: -0.078, output: -0.049, loss: 0.001

i: 878, target: -0.122, output: -0.048, loss: 0.005

i: 879, target: -0.130, output: -0.052, loss: 0.006

i: 880, target: -0.013, output: -0.049, loss: 0.001

i: 881, target: -0.180, output: -0.048, loss: 0.018

i: 882, target: -0.070, output: -0.050, loss: 0.000

i: 883, target: -0.131, output: -0.049, loss: 0.007

i: 884, target: -0.080, output: -0.051, loss: 0.001

i: 885, target: -0.116, output: -0.050, loss: 0.004

i: 886, target: -0.125, output: -0.047, loss: 0.006

i: 887, target: -0.071, output: -0.047, loss: 0.001

i: 888, target: -0.062, output: -0.050, loss: 0.000

i: 889, target: -0.150, output: -0.051, loss: 0.010

i: 890, target: -0.097, output: -0.052, loss: 0.002

i: 891, target: 0.043, output: -0.049, loss: 0.008

i: 892, target: -0.030, output: -0.051, loss: 0.000

i: 893, target: -0.076, output: -0.048, loss: 0.001
```

```
i: 894, target: 0.904, output: -0.050, loss: 0.912

i: 895, target: -0.090, output: -0.049, loss: 0.002

i: 896, target: -0.039, output: -0.048, loss: 0.000

i: 897, target: -0.188, output: -0.052, loss: 0.018

i: 898, target: -0.142, output: -0.050, loss: 0.008

i: 899, target: -0.095, output: -0.051, loss: 0.002

i: 900, target: -0.065, output: -0.048, loss: 0.000

i: 901, target: -0.132, output: -0.049, loss: 0.007

i: 902, target: -0.033, output: -0.052, loss: 0.000

i: 903, target: -0.145, output: -0.052, loss: 0.009

i: 904, target: -0.160, output: -0.048, loss: 0.013

i: 905, target: -0.061, output: -0.051, loss: 0.000

i: 906, target: -0.066, output: -0.049, loss: 0.000

i: 907, target: -0.020, output: -0.049, loss: 0.001

i: 908, target: -0.123, output: -0.048, loss: 0.006

i: 909, target: -0.041, output: -0.051, loss: 0.000

i: 910, target: -0.123, output: -0.052, loss: 0.005

i: 911, target: -0.085, output: -0.048, loss: 0.001

i: 912, target: -0.214, output: -0.051, loss: 0.026

i: 913, target: -0.152, output: -0.050, loss: 0.010

i: 914, target: -0.057, output: -0.048, loss: 0.000

i: 915, target: -0.051, output: -0.048, loss: 0.000

i: 916, target: -0.124, output: -0.052, loss: 0.005

i: 917, target: 0.036, output: -0.047, loss: 0.007
```

```
i: 918, target: -0.038, output: -0.051, loss: 0.000

i: 919, target: -0.059, output: -0.049, loss: 0.000

i: 920, target: -0.068, output: -0.051, loss: 0.000

i: 921, target: -0.127, output: -0.052, loss: 0.006

i: 922, target: -0.101, output: -0.048, loss: 0.003

i: 923, target: -0.056, output: -0.052, loss: 0.000

i: 924, target: -0.210, output: -0.050, loss: 0.026

i: 925, target: -0.175, output: -0.051, loss: 0.015

i: 926, target: -0.020, output: -0.050, loss: 0.001

i: 927, target: -0.194, output: -0.052, loss: 0.020

i: 928, target: -0.157, output: -0.052, loss: 0.011

i: 929, target: -0.175, output: -0.050, loss: 0.016

i: 930, target: -0.059, output: -0.051, loss: 0.000

i: 931, target: -0.208, output: -0.052, loss: 0.024

i: 932, target: -0.092, output: -0.048, loss: 0.002

i: 933, target: -0.084, output: -0.051, loss: 0.001

i: 934, target: -0.099, output: -0.051, loss: 0.002

i: 935, target: -0.096, output: -0.048, loss: 0.002

i: 936, target: -0.071, output: -0.052, loss: 0.000

i: 937, target: -0.158, output: -0.051, loss: 0.011

i: 938, target: -0.107, output: -0.048, loss: 0.003

i: 939, target: -0.151, output: -0.052, loss: 0.010

i: 940, target: -0.177, output: -0.049, loss: 0.016

i: 941, target: -0.096, output: -0.052, loss: 0.002
```

```
i: 942, target: -0.060, output: -0.052, loss: 0.000
i: 943, target: -0.074, output: -0.048, loss: 0.001
i: 944, target: 0.960, output: -0.047, loss: 1.014
i: 945, target: -0.141, output: -0.051, loss: 0.008
i: 946, target: -0.037, output: -0.051, loss: 0.000
i: 947, target: -0.040, output: -0.052, loss: 0.000
i: 948, target: -0.127, output: -0.048, loss: 0.006
i: 949, target: -0.137, output: -0.049, loss: 0.008
i: 950, target: -0.143, output: -0.051, loss: 0.008
i: 951, target: -0.038, output: -0.052, loss: 0.000
i: 952, target: 0.101, output: -0.051, loss: 0.023
i: 953, target: -0.042, output: -0.048, loss: 0.000
i: 954, target: 0.946, output: -0.048, loss: 0.988
i: 955, target: -0.075, output: -0.049, loss: 0.001
i: 956, target: -0.205, output: -0.051, loss: 0.024
i: 957, target: -0.149, output: -0.051, loss: 0.010
i: 958, target: -0.078, output: -0.050, loss: 0.001
i: 959, target: -0.043, output: -0.052, loss: 0.000
i: 960, target: -0.102, output: -0.048, loss: 0.003
i: 961, target: -0.054, output: -0.050, loss: 0.000
i: 962, target: -0.046, output: -0.052, loss: 0.000
i: 963, target: -0.075, output: -0.050, loss: 0.001
i: 964, target: -0.148, output: -0.048, loss: 0.010
i: 965, target: -0.107, output: -0.050, loss: 0.003
```

```
i: 966, target: -0.154, output: -0.051, loss: 0.011
i: 967, target: -0.027, output: -0.048, loss: 0.000
i: 968, target: -0.193, output: -0.052, loss: 0.020
i: 969, target: -0.151, output: -0.050, loss: 0.010
i: 970, target: -0.079, output: -0.051, loss: 0.001
i: 971, target: -0.102, output: -0.050, loss: 0.003
i: 972, target: -0.116, output: -0.049, loss: 0.004
i: 973, target: -0.059, output: -0.047, loss: 0.000
i: 974, target: -0.160, output: -0.051, loss: 0.012
i: 975, target: -0.202, output: -0.052, loss: 0.022
i: 976, target: -0.045, output: -0.051, loss: 0.000
i: 977, target: -0.052, output: -0.051, loss: 0.000
i: 978, target: -0.125, output: -0.050, loss: 0.006
i: 979, target: -0.159, output: -0.052, loss: 0.012
i: 980, target: -0.167, output: -0.049, loss: 0.014
i: 981, target: -0.042, output: -0.050, loss: 0.000
i: 982, target: -0.092, output: -0.049, loss: 0.002
i: 983, target: -0.043, output: -0.051, loss: 0.000
i: 984, target: -0.045, output: -0.048, loss: 0.000
i: 985, target: 0.829, output: -0.047, loss: 0.769
i: 986, target: -0.093, output: -0.052, loss: 0.002
i: 987, target: -0.060, output: -0.048, loss: 0.000
i: 988, target: -0.149, output: -0.051, loss: 0.010
i: 989, target: -0.145, output: -0.048, loss: 0.009
```

```
i: 990, target: -0.128, output: -0.052, loss: 0.006

i: 991, target: -0.047, output: -0.048, loss: 0.000

i: 992, target: -0.175, output: -0.049, loss: 0.016

i: 993, target: -0.103, output: -0.051, loss: 0.003

i: 994, target: -0.049, output: -0.052, loss: 0.000

i: 995, target: -0.083, output: -0.048, loss: 0.001

i: 996, target: -0.207, output: -0.051, loss: 0.024

i: 997, target: -0.055, output: -0.050, loss: 0.000

i: 998, target: -0.168, output: -0.051, loss: 0.014

i: 999, target: -0.142, output: -0.051, loss: 0.008

Average loss: 0.055
```

4 Save the Notebook as a PDF

[19]:
```
# SAVE THE NOTEBOOK

from IPython.display import Javascript

# Define the function to save the notebook
def save_notebook():
    display(Javascript('IPython.notebook.save_notebook()'))

# Call the save_notebook function to save the notebook
save_notebook()
```

```
<IPython.core.display.Javascript object>
```

[20]:
```
import subprocess
import os

name_notebook = "0724-small_hybrid_model_v4.ipynb"

output_filename = "results/"+ name_notebook[:4] +"/" + name_notebook[:-6] + "_0.
 ↪pdf"

#check if the output file already exists
while os.path.exists(output_filename):
```

```
    print("The file {} already exists".format(output_filename))
    output_filename = output_filename[:-5] + str(int(output_filename[-5]) + 1)␣
 ↪+ ".pdf"
    print("Trying to save the file as {}".format(output_filename))


subprocess.run(["jupyter", "nbconvert", "--to", "pdf", "--output",␣
 ↪output_filename, name_notebook])
```

[20]:
```
CompletedProcess(args=['jupyter', 'nbconvert', '--to', 'pdf', '--output',
'results/0724/0724-small_hybrid_model_v4_0.pdf',
'0724-small_hybrid_model_v4.ipynb'], returncode=0)
```