```python
# MK Lab 7
# Rafał Klinowski
# Zadanie 2
# Przy pomocy Keras
# nn_architecture = [
#     {"input_dim": 2, "output_dim": 2, "activation": "relu"},
#     {"input_dim": 2, "output_dim": 1, "activation": "tanh"}
# ]
import numpy as np
import tensorflow as tf
import keras.optimizers as opt
from keras.models import Sequential
from keras.layers import Dense
from copy import deepcopy

x = [[1,2],[2,4],[3,6],[4,8]]
y = [[2,4],[4,8],[6,12],[8,16]]

model = Sequential()
model.add(Dense(2, activation='relu', input_shape=(2,)))
model.add(Dense(1, activation='tanh'))
model.summary()
```

```
Model: "sequential_7"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense_14 (Dense)            (None, 2)                 6

 dense_15 (Dense)            (None, 1)                 3

=================================================================
Total params: 9 (36.00 Byte)
Trainable params: 9 (36.00 Byte)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

```python
print(model.get_weights())

sgd = opt.legacy.SGD(0.01)
model.compile(optimizer=sgd,loss='mean_squared_error',metrics=['accura
cy'])
```

```
[array([[-0.5762699,  1.1658314],
       [ 0.8121356, -1.0222448]], dtype=float32), array([0., 0.],
dtype=float32), array([[-0.72937614],
       [ 0.39224863]], dtype=float32), array([0.], dtype=float32)]
```

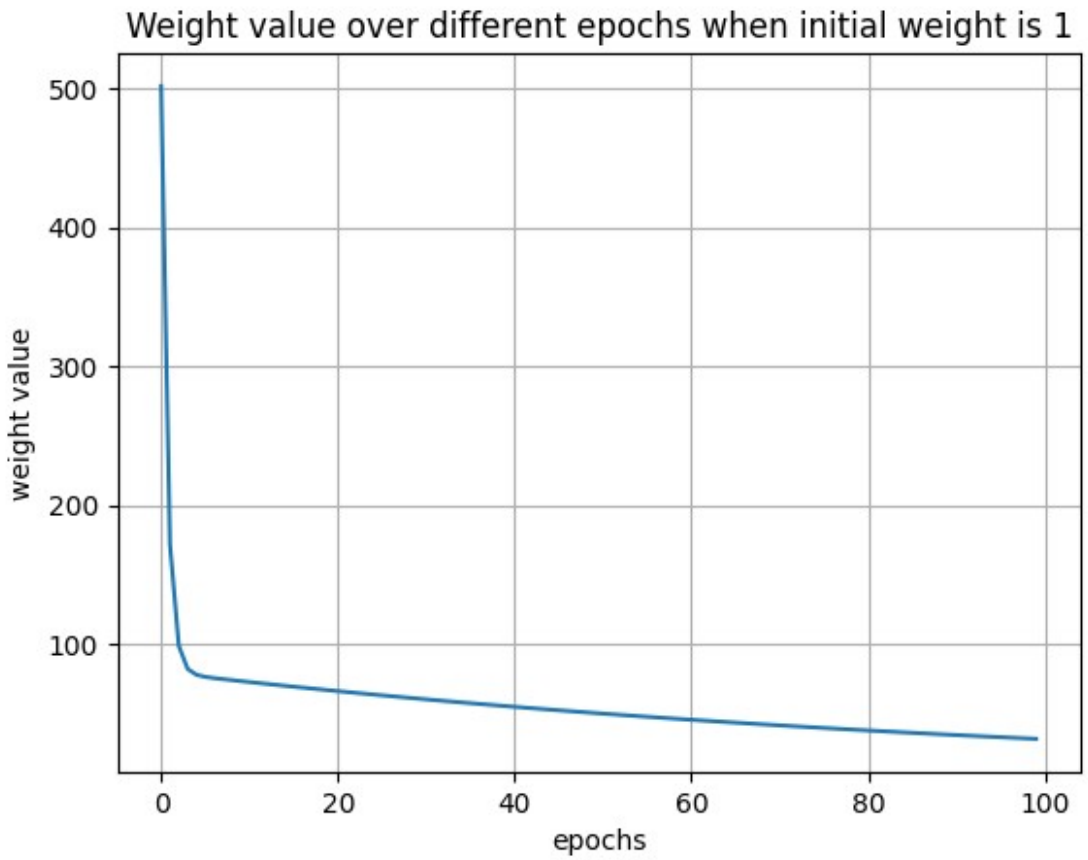
```
from copy import deepcopy
w = deepcopy(model.get_weights())
print(w)
```

```
[array([[-0.5762699,  1.1658314],
       [ 0.8121356, -1.0222448]], dtype=float32), array([0., 0.],
dtype=float32), array([[-0.72937614],
       [ 0.39224863]], dtype=float32), array([0.], dtype=float32)]
```

```
def feed_forward(inputs, outputs, weights):
    hidden = np.dot(inputs,weights[0])
    out = hidden+weights[1]
    squared_error = (np.square(out - outputs))
    return squared_error

def update_weights(inputs, outputs, weights, epochs):
    for epoch in range(epochs):
        org_loss = feed_forward(inputs, outputs, weights)
        wts_tmp = deepcopy(weights)
        wts_tmp2 = deepcopy(weights)
        for ix, wt in enumerate(weights):
            wts_tmp[-(ix+1)] += 0.0001
            # print('wts_tmp:', wts_tmp)
            loss = feed_forward(inputs, outputs, wts_tmp)
            # print('loss', loss)
            del_loss = np.sum(org_loss - loss)/(0.0001*len(inputs))
            wts_tmp2[-(ix+1)] += del_loss*0.01
            wts_tmp = deepcopy(weights)

        weights = deepcopy(wts_tmp2)
    return wts_tmp2

w = [2000, 0]
update_weights(x,y,w,1)

w_val = []
b_val = []
for k in range(100):
    w_new, b_new = update_weights(x,y,w,(k+1))
    w_val.append(w_new)
    b_val.append(b_new)

import matplotlib.pyplot as plt

print(w_val)

%matplotlib inline
plt.plot(w_val)
plt.title('Weight value over different epochs when initial weight is
1')
plt.xlabel('epochs')
```

```
plt.ylabel('weight value')
plt.grid('off')
```

```
[501.4999628183432, 171.82995344992378, 98.85300054193067,
82.25411458183771, 78.04194982745685, 76.55548817012914,
75.67301539852451, 74.92852875536755, 74.21963774522737,
73.52380546719814, 72.836032205646, 72.15517007991821,
71.4809175926348, 70.813159594627, 70.1518223326957,
69.49684161136247, 68.84815579251153, 68.20570425868482,
67.56942706840618, 66.93926487603221, 66.31515891299387,
65.69705097390397, 65.0848834148519, 64.4785991451954,
63.878141623627016, 63.28345485032969, 62.694483365999076,
62.11117224311238, 61.533467082063, 60.96131400654485,
60.39465965764066, 59.83345118913803, 59.27763626363003,
58.727163045762154, 58.181980197809935, 57.642036876836755,
57.1072827281796, 56.57766788057188, 56.05314294238042,
55.53365899626215, 55.01916759544656, 54.509620759199606,
54.00497096645722, 53.50517115441562, 53.01017471172145,
52.51993547503844, 52.03440772504564, 51.553546181435195,
51.077305999206146, 50.605642764890035, 50.13851249028676,
49.67587161206666, 49.21767698384656, 48.76388587492784,
48.31445596475987, 47.869345339358915, 47.42851248842044,
46.99191629977122, 46.55951605636801, 46.131271433034726,
45.707142491562536, 45.28708967812918, 44.87107381862643,
44.45905611554508, 44.05099814426876, 43.64686184947573,
43.24660954137016, 42.85020389278884, 42.45760793501745,
42.06878505477789, 41.68369899031745, 41.30231382885654,
40.92459400251869, 40.55050428531217, 40.18000978964551,
39.81307596336592, 39.44966858651924, 39.08975376755279,
38.73329794124061, 38.3802678644372, 38.03063061366743,
37.684353582170615, 37.34140447575669, 37.00175131165793,
36.66536241364042, 36.332206410219214, 36.00225223130451,
35.67546910566648, 35.351826557564436, 35.03129440416615,
34.713842752779556, 34.39944199779461, 34.088062818750586,
33.7796761761183, 33.474253310026825, 33.171765736824455,
32.872185246623076, 32.57548390058673, 32.28163402864084,
31.990608226163886]
```




```
w = list(model.get_weights().copy())
print(w)

update_weights(x,y,w,100)

model.fit(np.array(x), np.array(y), epochs=100, batch_size = 4,
verbose=1)

model.get_weights()
```

```
[array([[-0.5762699,  1.1658314],
       [ 0.8121356, -1.0222448]], dtype=float32), array([0., 0.],
dtype=float32), array([[-0.72937614],
       [ 0.39224863]], dtype=float32), array([0.], dtype=float32)]
Epoch 1/100
1/1 [==============================] - 0s 86ms/step - loss: 89.8774 -
accuracy: 0.0000e+00
Epoch 2/100
1/1 [==============================] - 0s 2ms/step - loss: 89.3749 -
accuracy: 0.0000e+00
Epoch 3/100
1/1 [==============================] - 0s 2ms/step - loss: 88.1712 -
accuracy: 0.0000e+00
```

```
Epoch 4/100
1/1 [==============================] - 0s 2ms/step - loss: 83.4989 -
accuracy: 0.0000e+00
Epoch 5/100
1/1 [==============================] - 0s 2ms/step - loss: 72.1252 -
accuracy: 0.0000e+00
Epoch 6/100
1/1 [==============================] - 0s 2ms/step - loss: 70.2300 -
accuracy: 0.0000e+00
Epoch 7/100
1/1 [==============================] - 0s 1ms/step - loss: 68.6692 -
accuracy: 0.0000e+00
Epoch 8/100
1/1 [==============================] - 0s 1ms/step - loss: 67.4309 -
accuracy: 0.0000e+00
Epoch 9/100
1/1 [==============================] - 0s 1ms/step - loss: 66.4625 -
accuracy: 0.0000e+00
Epoch 10/100
1/1 [==============================] - 0s 1ms/step - loss: 65.7045 -
accuracy: 0.0000e+00
Epoch 11/100
1/1 [==============================] - 0s 2ms/step - loss: 65.1057 -
accuracy: 0.0000e+00
Epoch 12/100
1/1 [==============================] - 0s 1ms/step - loss: 64.6264 -
accuracy: 0.0000e+00
Epoch 13/100
1/1 [==============================] - 0s 1ms/step - loss: 64.2375 -
accuracy: 0.0000e+00
Epoch 14/100
1/1 [==============================] - 0s 1ms/step - loss: 63.9173 -
accuracy: 0.0000e+00
Epoch 15/100
1/1 [==============================] - 0s 2ms/step - loss: 63.6505 -
accuracy: 0.0000e+00
Epoch 16/100
1/1 [==============================] - 0s 2ms/step - loss: 63.4253 -
accuracy: 0.0000e+00
Epoch 17/100
1/1 [==============================] - 0s 1ms/step - loss: 63.2332 -
accuracy: 0.0000e+00
Epoch 18/100
1/1 [==============================] - 0s 1ms/step - loss: 63.0677 -
accuracy: 0.0000e+00
Epoch 19/100
1/1 [==============================] - 0s 2ms/step - loss: 62.9239 -
accuracy: 0.0000e+00
Epoch 20/100
```

```
1/1 [==============================] - 0s 1ms/step - loss: 62.7979 -
accuracy: 0.0000e+00
Epoch 21/100
1/1 [==============================] - 0s 2ms/step - loss: 62.6867 -
accuracy: 0.0000e+00
Epoch 22/100
1/1 [==============================] - 0s 1ms/step - loss: 62.5879 -
accuracy: 0.0000e+00
Epoch 23/100
1/1 [==============================] - 0s 2ms/step - loss: 62.4996 -
accuracy: 0.0000e+00
Epoch 24/100
1/1 [==============================] - 0s 2ms/step - loss: 62.4203 -
accuracy: 0.0000e+00
Epoch 25/100
1/1 [==============================] - 0s 1ms/step - loss: 62.3487 -
accuracy: 0.0000e+00
Epoch 26/100
1/1 [==============================] - 0s 2ms/step - loss: 62.2838 -
accuracy: 0.0000e+00
Epoch 27/100
1/1 [==============================] - 0s 2ms/step - loss: 62.2246 -
accuracy: 0.0000e+00
Epoch 28/100
1/1 [==============================] - 0s 1ms/step - loss: 62.1705 -
accuracy: 0.0000e+00
Epoch 29/100
1/1 [==============================] - 0s 1ms/step - loss: 62.1208 -
accuracy: 0.0000e+00
Epoch 30/100
1/1 [==============================] - 0s 2ms/step - loss: 62.0751 -
accuracy: 0.0000e+00
Epoch 31/100
1/1 [==============================] - 0s 1ms/step - loss: 62.0329 -
accuracy: 0.0000e+00
Epoch 32/100
1/1 [==============================] - 0s 1ms/step - loss: 61.9938 -
accuracy: 0.0000e+00
Epoch 33/100
1/1 [==============================] - 0s 2ms/step - loss: 61.9575 -
accuracy: 0.0000e+00
Epoch 34/100
1/1 [==============================] - 0s 1ms/step - loss: 61.9236 -
accuracy: 0.0000e+00
Epoch 35/100
1/1 [==============================] - 0s 2ms/step - loss: 61.8921 -
accuracy: 0.0000e+00
Epoch 36/100
1/1 [==============================] - 0s 1ms/step - loss: 61.8625 -
```

```
accuracy: 0.0000e+00
Epoch 37/100
1/1 [==============================] - 0s 1ms/step - loss: 61.8349 -
accuracy: 0.0000e+00
Epoch 38/100
1/1 [==============================] - 0s 1ms/step - loss: 61.8089 -
accuracy: 0.0000e+00
Epoch 39/100
1/1 [==============================] - 0s 1ms/step - loss: 61.7844 -
accuracy: 0.0000e+00
Epoch 40/100
1/1 [==============================] - 0s 1ms/step - loss: 61.7614 -
accuracy: 0.0000e+00
Epoch 41/100
1/1 [==============================] - 0s 2ms/step - loss: 61.7397 -
accuracy: 0.0000e+00
Epoch 42/100
1/1 [==============================] - 0s 2ms/step - loss: 61.7191 -
accuracy: 0.0000e+00
Epoch 43/100
1/1 [==============================] - 0s 1ms/step - loss: 61.6996 -
accuracy: 0.0000e+00
Epoch 44/100
1/1 [==============================] - 0s 1ms/step - loss: 61.6812 -
accuracy: 0.0000e+00
Epoch 45/100
1/1 [==============================] - 0s 1ms/step - loss: 61.6637 -
accuracy: 0.0000e+00
Epoch 46/100
1/1 [==============================] - 0s 2ms/step - loss: 61.6470 -
accuracy: 0.0000e+00
Epoch 47/100
1/1 [==============================] - 0s 1ms/step - loss: 61.6312 -
accuracy: 0.0000e+00
Epoch 48/100
1/1 [==============================] - 0s 1ms/step - loss: 61.6161 -
accuracy: 0.0000e+00
Epoch 49/100
1/1 [==============================] - 0s 1ms/step - loss: 61.6016 -
accuracy: 0.0000e+00
Epoch 50/100
1/1 [==============================] - 0s 2ms/step - loss: 61.5879 -
accuracy: 0.0000e+00
Epoch 51/100
1/1 [==============================] - 0s 1ms/step - loss: 61.5747 -
accuracy: 0.0000e+00
Epoch 52/100
1/1 [==============================] - 0s 1ms/step - loss: 61.5621 -
accuracy: 0.0000e+00
```

```
Epoch 53/100
1/1 [==============================] - 0s 1ms/step - loss: 61.5501 -
accuracy: 0.0000e+00
Epoch 54/100
1/1 [==============================] - 0s 2ms/step - loss: 61.5385 -
accuracy: 0.0000e+00
Epoch 55/100
1/1 [==============================] - 0s 1ms/step - loss: 61.5275 -
accuracy: 0.0000e+00
Epoch 56/100
1/1 [==============================] - 0s 1ms/step - loss: 61.5168 -
accuracy: 0.0000e+00
Epoch 57/100
1/1 [==============================] - 0s 2ms/step - loss: 61.5066 -
accuracy: 0.0000e+00
Epoch 58/100
1/1 [==============================] - 0s 2ms/step - loss: 61.4968 -
accuracy: 0.0000e+00
Epoch 59/100
1/1 [==============================] - 0s 1ms/step - loss: 61.4873 -
accuracy: 0.0000e+00
Epoch 60/100
1/1 [==============================] - 0s 1ms/step - loss: 61.4782 -
accuracy: 0.0000e+00
Epoch 61/100
1/1 [==============================] - 0s 2ms/step - loss: 61.4694 -
accuracy: 0.0000e+00
Epoch 62/100
1/1 [==============================] - 0s 1ms/step - loss: 61.4609 -
accuracy: 0.0000e+00
Epoch 63/100
1/1 [==============================] - 0s 1ms/step - loss: 61.4527 -
accuracy: 0.0000e+00
Epoch 64/100
1/1 [==============================] - 0s 1ms/step - loss: 61.4449 -
accuracy: 0.0000e+00
Epoch 65/100
1/1 [==============================] - 0s 1ms/step - loss: 61.4372 -
accuracy: 0.0000e+00
Epoch 66/100
1/1 [==============================] - 0s 2ms/step - loss: 61.4299 -
accuracy: 0.0000e+00
Epoch 67/100
1/1 [==============================] - 0s 1ms/step - loss: 61.4227 -
accuracy: 0.0000e+00
Epoch 68/100
1/1 [==============================] - 0s 1ms/step - loss: 61.4158 -
accuracy: 0.0000e+00
Epoch 69/100
```

```
1/1 [==============================] - 0s 1ms/step - loss: 61.4092 -
accuracy: 0.0000e+00
Epoch 70/100
1/1 [==============================] - 0s 2ms/step - loss: 61.4027 -
accuracy: 0.0000e+00
Epoch 71/100
1/1 [==============================] - 0s 2ms/step - loss: 61.3964 -
accuracy: 0.0000e+00
Epoch 72/100
1/1 [==============================] - 0s 1ms/step - loss: 61.3904 -
accuracy: 0.0000e+00
Epoch 73/100
1/1 [==============================] - 0s 1ms/step - loss: 61.3845 -
accuracy: 0.0000e+00
Epoch 74/100
1/1 [==============================] - 0s 2ms/step - loss: 61.3787 -
accuracy: 0.0000e+00
Epoch 75/100
1/1 [==============================] - 0s 1ms/step - loss: 61.3732 -
accuracy: 0.0000e+00
Epoch 76/100
1/1 [==============================] - 0s 2ms/step - loss: 61.3678 -
accuracy: 0.0000e+00
Epoch 77/100
1/1 [==============================] - 0s 2ms/step - loss: 61.3625 -
accuracy: 0.0000e+00
Epoch 78/100
1/1 [==============================] - 0s 1ms/step - loss: 61.3574 -
accuracy: 0.0000e+00
Epoch 79/100
1/1 [==============================] - 0s 1ms/step - loss: 61.3525 -
accuracy: 0.0000e+00
Epoch 80/100
1/1 [==============================] - 0s 2ms/step - loss: 61.3477 -
accuracy: 0.0000e+00
Epoch 81/100
1/1 [==============================] - 0s 2ms/step - loss: 61.3430 -
accuracy: 0.0000e+00
Epoch 82/100
1/1 [==============================] - 0s 2ms/step - loss: 61.3384 -
accuracy: 0.0000e+00
Epoch 83/100
1/1 [==============================] - 0s 2ms/step - loss: 61.3339 -
accuracy: 0.0000e+00
Epoch 84/100
1/1 [==============================] - 0s 1ms/step - loss: 61.3296 -
accuracy: 0.0000e+00
Epoch 85/100
1/1 [==============================] - 0s 2ms/step - loss: 61.3254 -
```

```
accuracy: 0.0000e+00
Epoch 86/100
1/1 [==============================] - 0s 2ms/step - loss: 61.3213 -
accuracy: 0.0000e+00
Epoch 87/100
1/1 [==============================] - 0s 2ms/step - loss: 61.3172 -
accuracy: 0.0000e+00
Epoch 88/100
1/1 [==============================] - 0s 2ms/step - loss: 61.3133 -
accuracy: 0.0000e+00
Epoch 89/100
1/1 [==============================] - 0s 2ms/step - loss: 61.3095 -
accuracy: 0.0000e+00
Epoch 90/100
1/1 [==============================] - 0s 1ms/step - loss: 61.3058 -
accuracy: 0.0000e+00
Epoch 91/100
1/1 [==============================] - 0s 2ms/step - loss: 61.3021 -
accuracy: 0.0000e+00
Epoch 92/100
1/1 [==============================] - 0s 2ms/step - loss: 61.2986 -
accuracy: 0.0000e+00
Epoch 93/100
1/1 [==============================] - 0s 2ms/step - loss: 61.2951 -
accuracy: 0.0000e+00
Epoch 94/100
1/1 [==============================] - 0s 1ms/step - loss: 61.2917 -
accuracy: 0.0000e+00
Epoch 95/100
1/1 [==============================] - 0s 2ms/step - loss: 61.2884 -
accuracy: 0.0000e+00
Epoch 96/100
1/1 [==============================] - 0s 1ms/step - loss: 61.2851 -
accuracy: 0.0000e+00
Epoch 97/100
1/1 [==============================] - 0s 1ms/step - loss: 61.2819 -
accuracy: 0.0000e+00
Epoch 98/100
1/1 [==============================] - 0s 1ms/step - loss: 61.2788 -
accuracy: 0.0000e+00
Epoch 99/100
1/1 [==============================] - 0s 1ms/step - loss: 61.2758 -
accuracy: 0.0000e+00
Epoch 100/100
1/1 [==============================] - 0s 1ms/step - loss: 61.2728 -
accuracy: 0.0000e+00

[array([[-0.8625427 ,  1.1658314 ],
        [ 0.23958993, -1.0222448 ]], dtype=float32),
 array([-0.12325726,  0.        ], dtype=float32),
```

```
array([[-0.4562307 ],
       [ 0.39224863]], dtype=float32),
array([2.2794394], dtype=float32)]
```