six_layer_net.py

```
# coding: utf-8
import numpy as np
from common.layers import *
from common.gradient import numerical_gradient
from collections import OrderedDict
from common.optimizer import Adam

class sixLayerNet:

    def __init__(self, input_size, hidden_size1, hidden_size2, hidden_size3,
hidden_size4, hidden_size5, output_size, weight_init_std=0.1):
        # 가중치 초기화
        self.params = {}
        self.params['W1'] = weight_init_std * np.random.randn(input_size,
hidden_size1)
        self.params['b1'] = np.zeros(hidden_size1)
        self.params['W2'] = weight_init_std * np.random.randn(hidden_size1,
hidden_size2)
        self.params['b2'] = np.zeros(hidden_size2)
        self.params['W3'] = weight_init_std * np.random.randn(hidden_size2,
hidden_size3)
        self.params['b3'] = np.zeros(hidden_size3)
        self.params['W4'] = weight_init_std * np.random.randn(hidden_size3,
hidden_size4)
        self.params['b4'] = np.zeros(hidden_size4)
        self.params['W5'] = weight_init_std * np.random.randn(hidden_size4,
hidden_size5)
        self.params['b5'] = np.zeros(hidden_size5)
        self.params['W6'] = weight_init_std * np.random.randn(hidden_size5,
output_size)
        self.params['b6'] = np.zeros(output_size)

        # 정규화 파라미터
        self.gamma1 = np.ones(hidden_size1)
        self.beta1 = np.zeros(hidden_size1)
        self.gamma2 = np.ones(hidden_size2)
        self.beta2 = np.zeros(hidden_size2)
        self.gamma3 = np.ones(hidden_size3)
        self.beta3 = np.zeros(hidden_size3)
        self.gamma4 = np.ones(hidden_size4)
        self.beta4 = np.zeros(hidden_size4)
        self.gamma5 = np.ones(hidden_size5)
        self.beta5 = np.zeros(hidden_size5)

        # 계층 생성
        self.layers = OrderedDict()
        self.layers['Affine1'] = Affine(self.params['W1'], self.params['b1'])
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        self.layers['BatchNorm1'] = BatchNormalization(self.gamma1,
self.beta1)
        self.layers['Relu1'] = Relu()
        self.layers['Affine2'] = Affine(self.params['W2'], self.params['b2'])
        self.layers['BatchNorm2'] = BatchNormalization(self.gamma2,
self.beta2)
        self.layers['Relu2'] = Relu()
        self.layers['Affine3'] = Affine(self.params['W3'], self.params['b3'])
        self.layers['BatchNorm3'] = BatchNormalization(self.gamma3,
self.beta3)
        self.layers['Relu3'] = Relu()
        self.layers['Affine4'] = Affine(self.params['W4'], self.params['b4'])
        self.layers['BatchNorm4'] = BatchNormalization(self.gamma4,
self.beta4)
        self.layers['Relu4'] = Relu()
        self.layers['Affine5'] = Affine(self.params['W5'], self.params['b5'])
        self.layers['BatchNorm5'] = BatchNormalization(self.gamma5,
self.beta5)
        self.layers['Relu5'] = Relu()
        self.layers['Affine6'] = Affine(self.params['W6'], self.params['b6'])
        self.lastLayer = SoftmaxWithLoss()

        self.optimizer = Adam()

    def predict(self, x):
        for layer in self.layers.values():
            x = layer.forward(x)
        return x

    def loss(self, x, t):
        y = self.predict(x)
        return self.lastLayer.forward(y, t)

    def accuracy(self, x, t):
        y = self.predict(x)
        y = np.argmax(y, axis=1)
        if t.ndim != 1: t = np.argmax(t, axis=1)
        accuracy = np.sum(y == t) / float(x.shape[0])
        return accuracy

    def numerical_gradient(self, x, t):
        loss_W = lambda W: self.loss(x, t)
        grads = {}
        grads['W1'] = numerical_gradient(loss_W, self.params['W1'])
        grads['b1'] = numerical_gradient(loss_W, self.params['b1'])
        grads['W2'] = numerical_gradient(loss_W, self.params['W2'])
        grads['b2'] = numerical_gradient(loss_W, self.params['b2'])
        grads['W3'] = numerical_gradient(loss_W, self.params['W3'])
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        grads['b3'] = numerical_gradient(loss_W, self.params['b3'])
        grads['W4'] = numerical_gradient(loss_W, self.params['W4'])
        grads['b4'] = numerical_gradient(loss_W, self.params['b4'])
        grads['W5'] = numerical_gradient(loss_W, self.params['W5'])
        grads['b5'] = numerical_gradient(loss_W, self.params['b5'])
        grads['W6'] = numerical_gradient(loss_W, self.params['W6'])
        grads['b6'] = numerical_gradient(loss_W, self.params['b6'])
        return grads

    def gradient(self, x, t):
        # forward
        self.loss(x, t)
        # backward
        dout = 1
        dout = self.lastLayer.backward(dout)
        layers = list(self.layers.values())
        layers.reverse()
        for layer in layers:
            dout = layer.backward(dout)

        # 결과 저장
        grads = {}
        grads['W1'], grads['b1'] = self.layers['Affine1'].dW,
self.layers['Affine1'].db
        grads['W2'], grads['b2'] = self.layers['Affine2'].dW,
self.layers['Affine2'].db
        grads['W3'], grads['b3'] = self.layers['Affine3'].dW,
self.layers['Affine3'].db
        grads['W4'], grads['b4'] = self.layers['Affine4'].dW,
self.layers['Affine4'].db
        grads['W5'], grads['b5'] = self.layers['Affine5'].dW,
self.layers['Affine5'].db
        grads['W6'], grads['b6'] = self.layers['Affine6'].dW,
self.layers['Affine6'].db
        grads['gamma1'], grads['beta1'] = self.layers['BatchNorm1'].dgamma,
self.layers['BatchNorm1'].dbeta
        grads['gamma2'], grads['beta2'] = self.layers['BatchNorm2'].dgamma,
self.layers['BatchNorm2'].dbeta
        grads['gamma3'], grads['beta3'] = self.layers['BatchNorm3'].dgamma,
self.layers['BatchNorm3'].dbeta
        grads['gamma4'], grads['beta4'] = self.layers['BatchNorm4'].dgamma,
self.layers['BatchNorm4'].dbeta
        grads['gamma5'], grads['beta5'] = self.layers['BatchNorm5'].dgamma,
self.layers['BatchNorm5'].dbeta
        self.optimizer.update(self.params, grads)
        return grads
```

train_neuralnet2.py

```
# coding: utf-8
import sys, os
sys.path.append(os.pardir)

import numpy as np
from dataset.mnist import load_mnist
#from two_layer_net import TwoLayerNet
from six_layer_net import sixLayerNet
import matplotlib.pyplot as plt
from common.util import smooth_curve

# 데이터 읽기
(x_train, t_train), (x_test, t_test) = load_mnist(normalize=True,
one_hot_label=True)

network = sixLayerNet(input_size=784, hidden_size1=15, hidden_size2=14,
hidden_size3=13, hidden_size4 = 12, hidden_size5 = 11, output_size=10)
iters_num = 10000
train_size = x_train.shape[0]
batch_size = 480
learning_rate = 0.019

train_loss_list = []
train_acc_list = []
test_acc_list = []

iter_per_epoch = max(train_size / batch_size, 1)

for i in range(iters_num):
    batch_mask = np.random.choice(train_size, batch_size)
    x_batch = x_train[batch_mask]
    t_batch = t_train[batch_mask]

    # 기울기 계산
    grad = network.gradient(x_batch, t_batch)

    # 갱신
    for key in ('W1', 'b1', 'W2', 'b2', 'W3', 'b3', 'W4', 'b4', 'W5', 'b5',
'W6', 'b6'):
        network.params[key] -= learning_rate * grad[key]

    loss = network.loss(x_batch, t_batch)
    train_loss_list.append(loss)

    if i % iter_per_epoch == 0:
        train_acc = network.accuracy(x_train, t_train)
        test_acc = network.accuracy(x_test, t_test)
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        train_acc_list.append(train_acc)
        test_acc_list.append(test_acc)
        print("train acc:", train_acc, "test acc:", test_acc)

max_iterations = len(train_loss_list)
x = np.arange(max_iterations)

plt.plot(x, smooth_curve(train_loss_list))
plt.xlabel("iterations")
plt.ylabel("loss")
plt.ylim(0, 6)
plt.show()
```

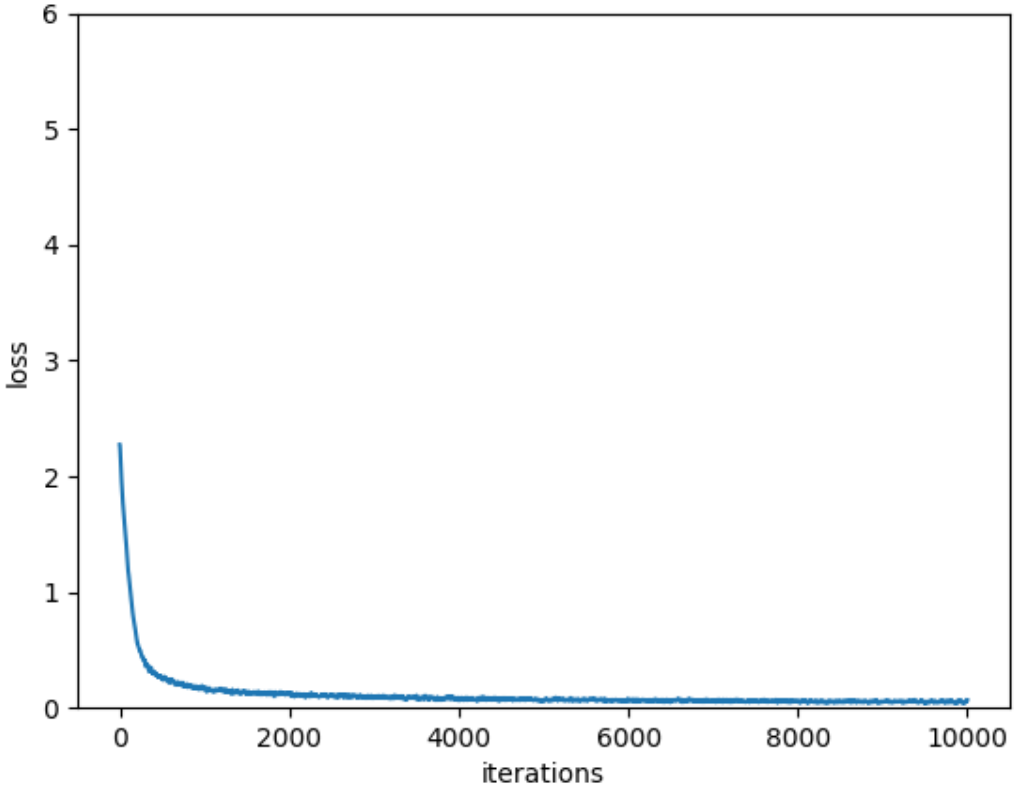

터미널 로그

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PS C:₩Users₩장주훈₩Desktop₩대학교₩3학년₩인공지능개론 - 최인엽교수님₩deep-learning-from-scratch-master> & C:/Users/장주훈/AppData/Local/Programs/Python/Python38-32/python.exe "c:/Users/장주훈/Desktop/대학교/3학년/인공지능개론 - 최인엽교수님/deep-learning-from-scratch-master/ch05/train_neuralnet2.py"
train acc: 0.11435 test acc: 0.1196
train acc: 0.6131333333333333 test acc: 0.6126
train acc: 0.82955 test acc: 0.8329
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