5.7.2 오차역전파법을 적용한 신경망 구현하기

계층을 사용함으로써 인식 결과를 얻는 처리(predict ( ))와 기울기를 구하는 처리(gradient ( )) 계층의 전파으로 동작이 이루어지는 것다.그럼 코드를 살펴보자

ch05/two_layer_net.py

```
import sys, os
sys.path.append(os.pardir)  # 부모 디렉터리의 파일을 가져올 수 있도록 설정
import numpy as np
from common.layers import *
from common.gradient import numerical_gradient
from collections import OrderedDict


class TwoLayerNet:

    def __init__(self, input_size, hidden_size, ou
        # 가중치 초기화
        self.params = {}
        self.params['W1'] = weight_init_std * np.r
        self.params['b1'] = np.zeros(hidden_size)
        self.params['W2'] = weight_init_std * np.r
        self.params['b2'] = np.zeros(output_size)

        # 계층 생성
        self.layers = OrderedDict()
        self.layers['Affine1'] = Affine(self.params['W1'], self.params['b1'])
        self.layers['Relu1'] = Relu()
        self.layers['Affine2'] = Affine(self.params['W2'], self.params['b2'])

        self.lastLayer = SoftmaxWithLoss()

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

        return x
```

```python
    # x : 입력 데이터, t : 정답 레이블
    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

    # x : 입력 데이터, t : 정답 레이블
    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'])

        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

        return grads
```

SECTION 05 오차역전파법

5.6.3 Softmax-with-Loss 계층

```python
class SoftmaxWithLoss:
    def __init__(self):
        self.loss = None # 손실함수
        self.y = None    # softmax의 출력
        self.t = None    # 정답 레이블(원-핫 인코딩 형태)

    def forward(self, x, t):
        self.t = t
        self.y = softmax(x)
        self.loss = cross_entropy_error(self.y, self.t)

        return self.loss

    def backward(self, dout=1):
        batch_size = self.t.shape[0]
        if self.t.size == self.y.size: # 정답 레이블이 원-핫 인코딩 형태일 때
            dx = (self.y - self.t) / batch_size
        else:
            dx = self.y.copy()
            dx[np.arange(batch_size), self.t] -= 1
            dx = dx / batch_size

        return dx
```

common/layers.py

```python
import numpy as np

def mean_squared_error (y,t):
    return 0.5*np.sum((y-t)**2)

t=[0,0,1,0,0,0,0,0,0,0]
y=[0.1,0.05,0.6,0.0,0.0,0.05,0.1,0.0,0.0,0.1,0.0,0.0]
print(mean_squared_error(np.array(y),np.array(t)))
```

p.179!

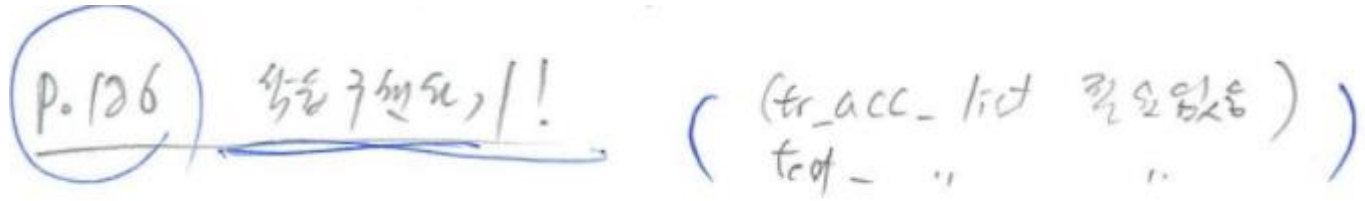
```
class LinearWithModErr
    def __init__(self):
        self.loss=None
        self.y = None
        self.t = None
    def forward(self, x, t):
        self.t = t
        self.y = x   # linear output
        self.loss = modified_error(self.y, self.t)
        return self.loss
    def backward(self, dout=1):
        batch_size = self.t.shape[0]
        dx = (self.t - self.y)**4/batch_size
        return dx

(p.118)  (p.113)
def modified_error(y, t):  # ~~log~~Regression
    batch_size = y.shape[0]
    return np.sum(0.25*(t-y)**4)/batch_size
```

$\frac{1}{n}(t-y)^n$

5.7.4 오차역전파법을 사용한 학습 구현하기

ch05/train_neuralnetOH.py

```
import sys, os
sys.path.append(os.pardir)

import numpy as np
from dataset.mnist import load_mnist
from two_layer_net import TwoLayerNet

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

network = TwoLayerNet(input_size=784, hidden_size=50, output_size=10)

iters_num = 10000
train_size = x_train.shape[0]
batch_size = 100
learning_rate = 0.1

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

iter_per_epoch = max(train_size / batch_size, 1)
```

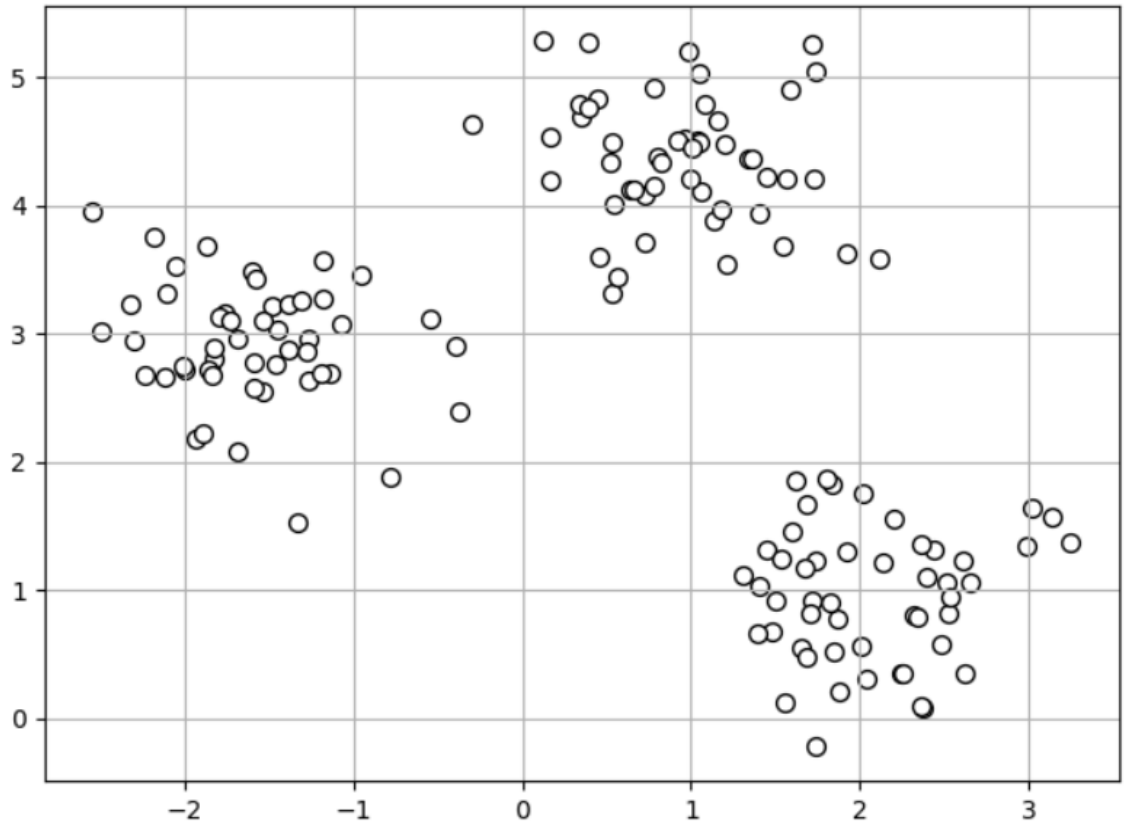


5.7.4 오차역전파법을 사용한 학습 구현하기

```
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.numerical_gradient(x_batch, t_batch) # 수치 미분 방식
    grad = network.gradient(x_batch, t_batch) # 오차역전파법 방식(훨씬 빠르다)

    # 갱신
    for key in ('W1', 'b1', 'W2', 'b2'):
        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)
        train_acc_list.append(train_acc)
        test_acc_list.append(test_acc)
        iter_num.append(i)
        print(i,train_acc, test_acc)

import matplotlib.pyplot as plt
plt.plot(iter_num,train_acc_list, label="train")
plt.plot(iter_num,test_acc_list, label="test")
plt.legend()
plt.show()
```

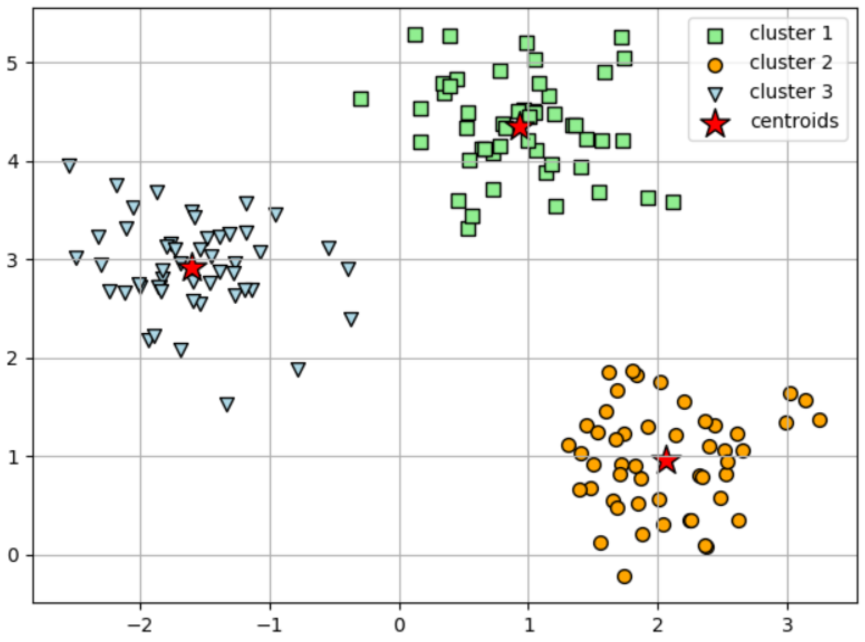
Clustering: K-means algorithm

```
# ## K-means clustering using scikit-learn

# In[3]:


from sklearn.datasets import make_blobs

X, y = make_blobs(n_samples=150,
                  n_features=2,
                  centers=3,
                  cluster_std=0.5,
                  shuffle=True,
                  random_state=0)


# In[4]:


import matplotlib.pyplot as plt

plt.scatter(X[:, 0], X[:, 1],
            c='white', marker='o', edgecolor='black', s=50)
plt.grid()
plt.tight_layout()
#plt.savefig('images/11_01.png', dpi=300)
plt.show()
```



Clustering: K-means algorithm

```python
from sklearn.cluster import KMeans

km = KMeans(n_clusters=3,
            init='random',
            n_init=10,
            max_iter=300,
            tol=1e-04,
            random_state=0)

y_km = km.fit_predict(X)

# In[6]:


plt.scatter(X[y_km == 0, 0],
            X[y_km == 0, 1],
            s=50, c='lightgreen',
            marker='s', edgecolor='black',
            label='cluster 1')
plt.scatter(X[y_km == 1, 0],
            X[y_km == 1, 1],
            s=50, c='orange',
            marker='o', edgecolor='black',
            label='cluster 2')
plt.scatter(X[y_km == 2, 0],
            X[y_km == 2, 1],
            s=50, c='lightblue',
            marker='v', edgecolor='black',
            label='cluster 3')
plt.scatter(km.cluster_centers_[:, 0],
            km.cluster_centers_[:, 1],
            s=250, marker='*',
            c='red', edgecolor='black',
            label='centroids')
plt.legend(scatterpoints=1)
plt.grid()
plt.tight_layout()
#plt.savefig('images/11_02.png', dpi=300)
plt.show()
```




```
>>> y.shape
(150,)
>>> X.shape
(150, 2)
>>> y_km.shape
(150,)
>>>
>>> y==y_km
array([ True,  True,  True,  True,  True,  True,  True,  True,  True,
        True,  True,  True,  True,  True,  True,  True,  True,  True,
        True,  True,  True,  True,  True,  True,  True,  True,  True,
        True,  True,  True,  True,  True,  True,  True,  True,  True,
        True,  True,  True,  True,  True,  True,  True,  True,  True,
        True,  True,  True,  True,  True,  True,  True,  True,  True,
        True,  True,  True,  True,  True,  True,  True,  True,  True,
        True,  True,  True,  True,  True,  True,  True,  True,  True,
        True,  True,  True,  True,  True,  True,  True,  True,  True,
        True,  True,  True,  True,  True,  True,  True,  True,  True,
        True,  True,  True,  True,  True,  True,  True,  True,  True,
        True,  True,  True,  True,  True,  True,  True,  True,  True,
        True,  True,  True,  True,  True,  True,  True,  True,  True,
        True,  True,  True,  True,  True,  True,  True,  True,  True,
        True,  True,  True,  True,  True,  True,  True,  True,  True,
        True,  True,  True,  True,  True,  True,  True,  True,  True,
        True,  True,  True,  True,  True,  True])
```