

[실습예제 25-2][도전!]

```
7 N, M = len(labels), len(np.unique(labels))
8 tt = np.eye(M)[labels,:]
9
10 for i in range(M):
11     ximin, ximax = np.min(xx[:,i]), np.max(xx[:,i])
12     xx[:,i] = -1 + 2*(xx[:,i]-ximin)/(ximax-ximin)
13
14 index = np.arange(N)
15 np.random.seed(1)
16 np.random.shuffle(index)
17 xx, tt = xx[index,:], tt[index,:]
18
19 phi = lambda u: 1/(1+np.exp(-u))
20 dphi = lambda u: np.exp(-u)/(1+np.exp(-u))**2
21 soft = lambda u: np.exp(u)/np.sum(np.exp(u),axis=1).reshape(-1,1)
22
23 D, L = 4, 7
24 np.random.seed(1)
25 b1, W1 = 2*np.random.rand(L)-1, 2*np.random.rand(D,L)-1
26 b2, W2 = 2*np.random.rand(3)-1, 2*np.random.rand(L,3)-1
27
28 BS = 10
29 BN = N//BS
30 MaxEpoch = 100
31 alpha = 1.0
32 ns = MaxEpoch/10
33
34 print('n={:3d}'.format(0))
35 for n in range(MaxEpoch):
36     for i in range(BN):
37         BX = xx[BS*i:BS*(i+1),:]
38         BT = tt[BS*i:BS*(i+1),:]
39         uh = b1 + BX@W1
40         zz = phi(uh)
41         uu = b2 + zz@W2
42         yy = soft(uu)
43
44         temp = np.sum((yy-BT)*yy,axis=1).reshape(-1,1)
45         dEdu2 = (yy-BT)*yy - temp*yy
46         gradb2 = 1/BS*np.sum(dEdu2,axis=0)
47         gradW2 = 1/BS*zz.T@dEdu2
48
49         dEdu1 = (dEdu2@W2.T)*dphi(uh)
50         gradb1 = 1/BS*np.sum(dEdu1,axis=0)
51         gradW1 = 1/BS*BX.T@dEdu1
52
53         b1, W1 = b1-alpha*gradb1, W1-alpha*gradW1
54         b2, W2 = b2-alpha*gradb2, W2-alpha*gradW2
55
56     uh = b1 + xx@W1
57     uu = b2 + phi(uh)@W2
```

```
58 yy = soft(uu)
59 Eval = 0.5/N*np.sum((yy-tt)**2)
60 acc = 100*np.mean(np.argmax(yy,axis=1)==np.argmax(tt,axis=1))
61
62 if (n+1)%ns == 0:
63     print('n={:3d}, Eval={:.4f}, Acc={:5.1f}%'.format(n+1,Eval,acc))
```

```
n= 0
n= 10, Eval=0.0966, Acc= 88.7%
n= 20, Eval=0.0563, Acc= 94.0%
n= 30, Eval=0.0352, Acc= 96.7%
n= 40, Eval=0.0260, Acc= 97.3%
n= 50, Eval=0.0219, Acc= 97.3%
n= 60, Eval=0.0198, Acc= 98.7%
n= 70, Eval=0.0185, Acc= 98.7%
n= 80, Eval=0.0177, Acc= 98.7%
n= 90, Eval=0.0171, Acc= 98.7%
n=100, Eval=0.0166, Acc= 98.7%
```
