

[실습예제 24-2][도전!]

```
19 phi = lambda u: 1/(1+np.exp(-u))
20 dphi = lambda u: np.exp(-u)/(1+np.exp(-u))**2
21
22 soft = lambda u: np.exp(u)/np.sum(np.exp(u),axis=1).reshape(-1,1)
23
24 np.random.seed(1)
25 L = 7
26 b1, W1 = np.random.rand(L), np.random.rand(2,L)
27 b2, W2 = np.random.rand(3), np.random.rand(L,3)
28
29 MaxIter = 10000
30 alpha = 1.0
31 ns = MaxIter/10
32
33 print('n={:5d}'.format(0))
34 for n in range(MaxIter):
35     uh = b1 + xx@W1
36     zz = phi(uh)
37     uu = b2 + zz@W2
38     yy = soft(uu)
39
40     temp = np.reshape(np.sum((yy-tt)*yy,axis=1),(-1,1))
41     dEdu2 = (yy-tt)*yy-temp*yy
42     gradb2 = 1/N*np.sum(dEdu2,axis=0)
43     gradW2 = 1/N*zz.T@dEdu2
44
45     dEdu1 = (dEdu2@W2.T)*dphi(uh)
46     gradb1 = 1/N*np.sum(dEdu1,axis=0)
47     gradW1 = 1/N*xx.T@dEdu1
48
49     b1, W1 = b1-alpha*gradb1, W1-alpha*gradW1
50     b2, W2 = b2-alpha*gradb2, W2-alpha*gradW2
51
52     uh = b1 + xx@W1
53     uu = b2 + phi(uh)@W2
54     Eval = 0.5/N*np.sum((soft(uu)-tt)**2)
55     acc = np.sum(np.argmax(yy,axis=1)-np.argmax(tt,axis=1)==0)/N*100
56
57     if (n+1)%ns == 0:
58         print('n={:5d}, Eval={:.4f}, Acc={:5.1f}%'.format(n+1,Eval,acc))
```

```
n=      0
n= 1000, Eval=0.1608, Acc= 80.0%
n= 2000, Eval=0.0851, Acc= 90.0%
n= 3000, Eval=0.0373, Acc= 99.0%
n= 4000, Eval=0.0218, Acc=100.0%
n= 5000, Eval=0.0152, Acc=100.0%
n= 6000, Eval=0.0117, Acc=100.0%
n= 7000, Eval=0.0095, Acc=100.0%
n= 8000, Eval=0.0079, Acc=100.0%
n= 9000, Eval=0.0067, Acc=100.0%
```

n=10000, Eval=0.0058, Acc=100.0%

```
59 x1 = np.linspace(-1, 1)
60 x2 = np.linspace(-1, 1)
61 xx1, xx2 = np.meshgrid(x1, x2)
62 XX = np.column_stack((xx1.reshape(-1),xx2.reshape(-1)))
63 UH = b1 + XX@W1
64 UU = b2 + phi(UH)@W2
65 YY = soft(UU)
66 yy = [YY[:,j].reshape(xx1.shape) for j in range(3)]
67
68 fig = plt.figure()
69 ax = plt.axes()
70 gcmap = plt.colormaps.get_cmap('brg')
71 ax.scatter(xx[:,0], xx[:,1], c=labels, cmap=gcmap)
72 for j in range(3):
73     ax.contour(xx1, xx2, yy[j], [0.5])
74     ax.contourf(xx1, xx2, yy[j], [0.5,1.0], colors=[gcmap(j/2)], alpha=0.3)
75 ax.set_aspect('equal')
76 plt.show()
```

