

[실습예제 15-2][도전!]

```
15 phi = lambda u: 1/(1+np.exp(-u))
16 dphi = lambda u: np.exp(-u)/(1+np.exp(-u))**2
17
18 np.random.seed(1)
19 L = 4
20 W, V = np.random.rand(L+1,3), np.random.rand(L+1)
21 MaxIter = 10000
22 alpha = 1.0
23 ns = MaxIter/10
24 print('n={:5d}'.format(0))
25 for n in range(MaxIter):
26     gradW, gradV = np.zeros((L+1,3)), np.zeros(L+1)
27     for i in range(N):
28         uh = np.zeros(L+1)
29         for j in range(1,L+1):
30             uh[j] = W[j,0] + W[j,1]*x[1,i] + W[j,2]*x[2,i]
31
32         ui = V[0]
33         for j in range(1,L+1):
34             ui += V[j]*phi(uh[j])
35
36         dEdu = (phi(ui)-t[i])*dphi(ui)
37         gradV[0] += 1/N*dEdu
38         for j in range(1,L+1):
39             gradV[j] += 1/N*dEdu*phi(uh[j])
40
41         for j in range(1,L+1):
42             dEduh = dEdu*V[j]*dphi(uh[j])
43             gradW[j,0] += 1/N*dEduh
44             for k in range(1,3):
45                 gradW[j,k] += 1/N*dEduh*x[k,i]
46
47     W, V = W-alpha*gradW, V-alpha*gradV
48
49     Eval = 0.0
50     for i in range(N):
51         uh = np.zeros(L+1)
52         for j in range(1,L+1):
53             uh[j] = W[j,0] + W[j,1]*x[1,i] + W[j,2]*x[2,i]
54
55         ui = V[0]
56         for j in range(1,L+1):
57             ui += V[j]*phi(uh[j])
58
59         Eval += 0.5/N*(phi(ui)-t[i])**2
60
61     if (n+1)%ns == 0:
62         print('n={:5d}, Eval={: .4f}'.format(n+1,Eval))
```

n= 0

n= 1000, Eval=0.0561

```
n= 2000, Eval=0.0428
n= 3000, Eval=0.0049
n= 4000, Eval=0.0020
n= 5000, Eval=0.0012
n= 6000, Eval=0.0008
n= 7000, Eval=0.0006
n= 8000, Eval=0.0005
n= 9000, Eval=0.0004
n=10000, Eval=0.0004
```

```
63 x1 = np.linspace(-1.5, 1.5)
64 x2 = np.linspace(-1.5, 1.5)
65 xx1, xx2 = np.meshgrid(x1, x2)
66
67 uuh = [0 for j in range(L+1)]
68 for j in range(1,L+1):
69     uuh[j] = W[j,0] + W[j,1]*xx1 + W[j,2]*xx2
70
71 uu = V[0]
72 for j in range(1,L+1):
73     uu += V[j]*phi(uuh[j])
74
75 yy = phi(uu)
76
77 fig = plt.figure()
78 ax = plt.axes()
79 ax.set_aspect('equal')
80 ax.scatter(x[1:], x[2:], c=t, cmap='bwr')
81 ax.contour(xx1, xx2, yy, [0.5])
82 plt.show()
```

