

[실습예제 16-2][도전!]

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

```

64         Eval += 0.5/N*(phi(ui[j])-t[j,i])**2
65
66     if (n+1)%ns == 0:
67         print('n={:5d}, Eval={:.4f}'.format(n+1,Eval))

```



```

n=      0
n= 1000, Eval=0.1026
n= 2000, Eval=0.0098
n= 3000, Eval=0.0042
n= 4000, Eval=0.0026
n= 5000, Eval=0.0019
n= 6000, Eval=0.0014
n= 7000, Eval=0.0012
n= 8000, Eval=0.0010
n= 9000, Eval=0.0009
n=10000, Eval=0.0007

```



```

68 x1 = np.linspace(-1.5, 1.5)
69 x2 = np.linspace(-1.5, 1.5)
70 xx1, xx2 = np.meshgrid(x1, x2)
71
72 uuh = [0 for k in range(L+1)]
73 for k in range(1,L+1):
74     uuh[k] = W[k,0] + W[k,1]*xx1 + W[k,2]*xx2
75
76 yy = [0 for j in range(4)]
77 for j in range(1,4):
78     uu = V[j,0]
79     for k in range(1,L+1):
80         uu += V[j,k]*phi(uuh[k])
81     yy[j] = phi(uu)
82
83 fig = plt.figure()
84 ax = plt.axes()
85 ax.set_aspect('equal')
86 ax.scatter(x[1,:], x[2,:], c=t[2,:]+2*t[3,:], cmap='brg')
87 for j in range(1,4):
88     ax.contour(xx1, xx2, yy[j], [0.5])
89 plt.show()

```

