

[실습예제 14-3][도전!]

```
13 phi = lambda u: 1/(1+np.exp(-u))
14 dphi = lambda u: np.exp(-u)/(1+np.exp(-u))**2
15
16 np.random.seed(17)
17 oldW, oldV = np.random.rand(4,3), np.random.rand(4)
18 MaxIter = 10000
19 alpha = 1.0
20 ns = MaxIter/10
21 print('n={:5d}'.format(0))
22 for n in range(MaxIter):
23     gradW, gradV = np.zeros((4,3)), np.zeros(4)
24     for i in range(N):
25         x1, x2 = x[1,i], x[2,i]
26         u1h = oldW[1,0] + oldW[1,1]*x1 + oldW[1,2]*x2
27         u2h = oldW[2,0] + oldW[2,1]*x1 + oldW[2,2]*x2
28         u3h = oldW[3,0] + oldW[3,1]*x1 + oldW[3,2]*x2
29         z1, z2, z3 = phi(u1h), phi(u2h), phi(u3h)
30         v0, v1, v2, v3 = oldV[0], oldV[1], oldV[2], oldV[3]
31         ui = v0 + v1*z1 + v2*z2 + v3*z3
32         tempW = [[
33             0, 0, 0,
34             [v1*dphi(u1h), v1*dphi(u1h)*x1, v1*dphi(u1h)*x2],
35             [v2*dphi(u2h), v2*dphi(u2h)*x1, v2*dphi(u2h)*x2],
36             [v3*dphi(u3h), v3*dphi(u3h)*x1, v3*dphi(u3h)*x2]]
37         gradW += 1/N*(phi(ui)-t[i])*dphi(ui)*np.array(tempW)
38         gradV += 1/N*(phi(ui)-t[i])*dphi(ui)*np.array([1,z1,z2,z3])
39
40 newW, newV = oldW-alpha*gradW, oldV-alpha*gradV
41 oldW, oldV = newW.copy(), newV.copy()
42
43 Eval = 0.0
44 for i in range(N):
45     u1h = oldW[1,0] + oldW[1,1]*x[1,i] + oldW[1,2]*x[2,i]
46     u2h = oldW[2,0] + oldW[2,1]*x[1,i] + oldW[2,2]*x[2,i]
47     u3h = oldW[3,0] + oldW[3,1]*x[1,i] + oldW[3,2]*x[2,i]
48     ui = oldV[0] + oldV[1]*phi(u1h) + oldV[2]*phi(u2h) + oldV[3]*phi(u3h)
49     Eval += 0.5/N*(phi(ui)-t[i])**2
50
51 if (n+1)%ns == 0:
52     print('n={:5d}, Eval={:.4f}'.format(n+1,Eval))
```

```
n= 0
n= 1000, Eval=0.0100
n= 2000, Eval=0.0023
n= 3000, Eval=0.0012
n= 4000, Eval=0.0008
n= 5000, Eval=0.0006
n= 6000, Eval=0.0005
n= 7000, Eval=0.0004
n= 8000, Eval=0.0003
n= 9000, Eval=0.0003
n=10000, Eval=0.0003
```

```

52 x1 = np.linspace(-1.5, 1.5)
53 x2 = np.linspace(-1.5, 1.5)
54 xx1, xx2 = np.meshgrid(x1, x2)
55 uh1 = oldW[1,0] + oldW[1,1]*xx1 + oldW[1,2]*xx2
56 uh2 = oldW[2,0] + oldW[2,1]*xx1 + oldW[2,2]*xx2
57 uh3 = oldW[3,0] + oldW[3,1]*xx1 + oldW[3,2]*xx2
58 yy = phi(oldV[0]+oldV[1]*phi(uh1)+oldV[2]*phi(uh2)+oldV[3]*phi(uh3))
59
60 fig = plt.figure()
61 ax = plt.axes()
62 ax.scatter(x[1:], x[2:], c=t, cmap='bwr')
63 ax.contour(xx1, xx2, yy, [0.5])
64 ax.set_aspect('equal')
65 plt.show()

```

