

[실습예제 19-2][도전!]

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18 phi = lambda u: 1/(1+np.exp(-u))
19 dphi = lambda u: np.exp(-u)/(1+np.exp(-u))**2
20
21 np.random.seed(1)
22 L1, L2, L3 = 6, 5, 4
23 b1, W1 = np.random.rand(L1,1), np.random.rand(L1,2)
24 b2, W2 = np.random.rand(L2,1), np.random.rand(L2,L1)
25 b3, W3 = np.random.rand(L3,1), np.random.rand(L3,L2)
26 b4, W4 = np.random.rand(3,1), np.random.rand(3,L3)
27
28 MaxIter = 10000
29 alpha = 1.0
30 ns = MaxIter/10
31
32 print('n={:5d}'.format(0))
33 for n in range(MaxIter):
34     gradb1, gradW1 = np.zeros((L1,1)), np.zeros((L1,2))
35     gradb2, gradW2 = np.zeros((L2,1)), np.zeros((L2,L1))
36     gradb3, gradW3 = np.zeros((L3,1)), np.zeros((L3,L2))
37     gradb4, gradW4 = np.zeros((3,1)), np.zeros((3,L3))
38     for i in range(N):
39         ti = t[:,i:i+1]
40         xi = x[:,i:i+1]
41         uh1 = b1 + W1@xi
42         z1 = phi(uh1)
43         uh2 = b2 + W2@z1
44         z2 = phi(uh2)
45         uh3 = b3 + W3@z2
46         z3 = phi(uh3)
47         ui = b4 + W4@z3
48
49         dEdu = dphi(ui)*(phi(ui)-ti)
50         gradb4 += 1/N*dEdu
51         gradW4 += 1/N*dEdu@z3.T
52
53         dEduh3 = dphi(uh3)*(W4.T@dEdu)
54         gradb3 += 1/N*dEduh3
55         gradW3 += 1/N*dEduh3@z2.T
56
57         dEduh2 = dphi(uh2)*(W3.T@dEduh3)
58         gradb2 += 1/N*dEduh2
59         gradW2 += 1/N*dEduh2@z1.T
60
61         dEduh1 = dphi(uh1)*(W2.T@dEduh2)
62         gradb1 += 1/N*dEduh1
63         gradW1 += 1/N*dEduh1@xi.T
64
65     b1, W1 = b1-alpha*gradb1, W1-alpha*gradW1
66     b2, W2 = b2-alpha*gradb2, W2-alpha*gradW2
67     b3, W3 = b3-alpha*gradb3, W3-alpha*gradW3
68     b4, W4 = b4-alpha*gradb4, W4-alpha*gradW4
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69
70     Eval = 0.0
71     for i in range(N):
72         ti = t[:,i:i+1]
73         xi = x[:,i:i+1]
74         uh1 = b1 + W1@xi
75         z1 = phi(uh1)
76         uh2 = b2 + W2@z1
77         z2 = phi(uh2)
78         uh3 = b3 + W3@z2
79         z3 = phi(uh3)
80         ui = b4 + W4@z3
81
82         Eval += 0.5/N*np.sum((phi(ui)-ti)**2)
83
84     if (n+1)%ns == 0:
85         print('n={:5d}, Eval={:.4f}'.format(n+1,Eval))

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n=      0
n= 1000, Eval=0.3318
n= 2000, Eval=0.3304
n= 3000, Eval=0.2303
n= 4000, Eval=0.2235
n= 5000, Eval=0.2147
n= 6000, Eval=0.1838
n= 7000, Eval=0.1015
n= 8000, Eval=0.0249
n= 9000, Eval=0.0096
n=10000, Eval=0.0061

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86 x1 = np.linspace(-1, 1)
87 x2 = np.linspace(-1, 1)
88 xx1, xx2 = np.meshgrid(x1, x2)
89
90 uuh1 = [0 for m in range(L1)]
91 for m in range(L1):
92     uuh1[m] = b1[m,0] + W1[m,0]*xx1 + W1[m,1]*xx2
93
94 uuh2 = [0 for l in range(L2)]
95 for l in range(L2):
96     uuh2[l] = b2[l,0]
97     for m in range(L1):
98         uuh2[l] += W2[l,m]*phi(uuh1[m])
99
100 uuh3 = [0 for k in range(L3)]
101 for k in range(L3):
102     uuh3[k] = b3[k,0]
103     for l in range(L2):
104         uuh3[k] += W3[k,l]*phi(uuh2[l])
105
106 yy = [0 for j in range(3)]
107 for j in range(3):
108     uu = b4[j,0]
109     for k in range(L3):

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110     uu += W4[j,k]*phi(uuh3[k])
111     yy[j] = phi(uu)
112
113 fig = plt.figure()
114 ax = plt.axes()
115 ax.scatter(x[0,:], x[1,:], c=t[1,:]+2*t[2,:], cmap='brg')
116 for j in range(3):
117     ax.contour(xx1, xx2, yy[j], [0.5])
118 ax.set_aspect('equal')
119 plt.show()

```

