11주차 실습과제

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문제 1. 프로그램 4-4를 수행하여 결과를 정리하시오

(1) 각 Iteration 당 Loss

10회 연속 Training Loss가 개선되지 않아 총 84 iteration 수행 후 학습 중단

```
Iteration 1, loss = 0.62904900
Iteration 2, loss = 0.26534751
Iteration 3, loss = 0.20890938
Iteration 4, loss = 0.17398247
Iteration 5, loss = 0.14981875
Iteration 6, loss = 0.13171202
Iteration 7, loss = 0.11704198
Iteration 8, loss = 0.10477879
Iteration 9, loss = 0.09455242
Iteration 10, loss = 0.08511157
Iteration 11, loss = 0.07864917
Iteration 12, loss = 0.07136284
Iteration 13, loss = 0.06588086
Iteration 14, loss = 0.06039559
Iteration 15, loss = 0.05636838
Iteration 16, loss = 0.05134130
Iteration 17, loss = 0.04748849
Iteration 18, loss = 0.04414181
Iteration 19, loss = 0.04058281
Iteration 20, loss = 0.03816337
Iteration 21, loss = 0.03523681
Iteration 22, loss = 0.03217988
Iteration 23, loss = 0.02998668
Iteration 24, loss = 0.02835019
Iteration 25, loss = 0.02603920
Iteration 26, loss = 0.02439807
Iteration 27, loss = 0.02261790
Iteration 28, loss = 0.02101092
Iteration 29, loss = 0.01934916
Iteration 30, loss = 0.01780207
Iteration 31, loss = 0.01712957
Iteration 32, loss = 0.01522585
Iteration 33, loss = 0.01430702
Iteration 34, loss = 0.01303774
Iteration 35, loss = 0.01257436
Iteration 36, loss = 0.01155260
Iteration 37, loss = 0.01084535
Iteration 38, loss = 0.00995289
Iteration 39, loss = 0.00929207
Iteration 40, loss = 0.00873320
Iteration 41, loss = 0.00802749
Iteration 42, loss = 0.00726682
Iteration 43, loss = 0.00710505
Iteration 44, loss = 0.00636062
Iteration 45, loss = 0.00596729
Iteration 46, loss = 0.00575964
Iteration 47, loss = 0.00517294
Iteration 48, loss = 0.00470975
Iteration 49, loss = 0.00465719
Iteration 50, loss = 0.00411796
Iteration 51, loss = 0.00379917
Iteration 52, loss = 0.00368039
Iteration 53, loss = 0.00344525
Iteration 54, loss = 0.00354652
Iteration 55, loss = 0.00307691
Iteration 56, loss = 0.00281632
Iteration 57, loss = 0.00293890
Iteration 58, loss = 0.00245350
Iteration 59, loss = 0.00221916
Iteration 60, loss = 0.00210120
Iteration 61, loss = 0.00205558
Iteration 62, loss = 0.00195135
Iteration 63, loss = 0.00187095
Iteration 64, loss = 0.00176764
Iteration 65, loss = 0.00194078
Iteration 66, loss = 0.00150953
Iteration 67, loss = 0.00149220
Iteration 68, loss = 0.00138560
Iteration 69, loss = 0.00124520
Iteration 70, loss = 0.00122585
Iteration 71, loss = 0.00116436
Iteration 72, loss = 0.00119129
Iteration 73, loss = 0.00106301
Iteration 74, loss = 0.00100339
Iteration 75, loss = 0.00097040
Iteration 76, loss = 0.00090855
Iteration 77, loss = 0.00087342
Iteration 78, loss = 0.00083134
Iteration 79, loss = 0.00079755
Iteration 80, loss = 0.00080702
Iteration 81, loss = 0.00077074
Iteration 82, loss = 0.00073533
Iteration 83, loss = 0.00068695
Iteration 84, loss = 0.00066205
```

(2) 혼동행렬 및 정확도

혼동행렬의 주대각선 부분 : TP / 혼동행렬의 주대각선 제외 부분 : FP

정확도 = TP / 전체 데이터 개수

```
Training loss did not improve more than tol=0.000100 for 10 consecutive epochs. Stopping.
[[ 969    0    5    0    1    2    4    0    2    3]
 [   0 1124    1    0    1    1    1    4    1    2]
 [   2    3 1007    1    2    0    3    8    2    0]
 [   0    1    0  990    0   13    1    3    6    4]
 [   2    0    1    1  958    1    3    2    7    8]
 [   0    0    0    3    0  867    4    1    2    2]
 [   3    2    4    0    7    2  940    0    3    0]
 [   1    1    4    3    0    1    0  999    3    3]
 [   3    4    9    6    1    3    2    3  945    4]
 [   0    0    1    6   12    2    0    8    3  983]]
테스트 집합에 대한 정확률은 97.82 %입니다.
```

문제 2. 프로그램 4-4의 동작을 설명하시오

(1) 라이브러리 import

```
from sklearn.datasets import fetch_openml
from sklearn.neural_network import MLPClassifier
import matplotlib.pyplot as plt
import numpy as np
```

(2) MNIST 데이터셋 불러오기

```
mnist=fetch_openml('mnist_784')
```

(3) MNIST 데이터를 0~1 사이 값으로 정규화

```
mnist.data=mnist.data/255.0
```

(4) TrainSet과 TestSet 생성 (각각 60000개, 10000개)

```
x_train=mnist.data[:60000]; x_test=mnist.data[60000:]
y_train=np.int16(mnist.target[:60000]); y_test=np.int16(mnist.target[60000:])
```

(5) MLP 분류기 모델 생성 : 히든레이어 100, 학습율 0.001, 배치사이즈 512, 최대반복 300

```
mlp=MLPClassifier(hidden_layer_sizes=(100),learning_rate_init=0.001,batch_size=512,max_iter
=300,solver='adam',verbose=True)
```

(6) MLP 분류기 모델 학습

```
mlp.fit(x_train,y_train)
```

(7) TestSet을 사용하여 정답 예측

```
res=mlp.predict(x_test)
```

(8) 혼동 행렬 생성 후 출력 (혼동행렬의 주대각선 : TP, 나머지 : FP)

```
conf=np.zeros((10,10),dtype=np.int16)
for i in range(len(res)):
    conf[res[i]][y_test[i]]+=1
print(conf)
```

(9) 정확도 계산 후 출력 (혼동행렬의 TP 개수 / 전차 데이터 개수)

```
no_correct=0
for i in range(10):
    no_correct+=conf[i][i]
accuracy=no_correct/len(res)
print("테스트 집합에 대한 정확률은", accuracy*100, "%입니다.")
```

문제 3. Batch size 128, Hidden layer 50인 경우의 수행 결과와 비교하시오

```
Iteration 1, loss = 0.44606425
Iteration 2, loss = 0.21067316
Iteration 3, loss = 0.16386934
Iteration 4, loss = 0.13459966
Iteration 5, loss = 0.11531701
Iteration 6, loss = 0.10118774
Iteration 7, loss = 0.08932158
Iteration 8, loss = 0.08097207
Iteration 9, loss = 0.07430534
Iteration 10, loss = 0.06647300
Iteration 11, loss = 0.06195288
Iteration 12, loss = 0.05641611
Iteration 13, loss = 0.05190365
Iteration 14, loss = 0.04807438
Iteration 15, loss = 0.04436392
Iteration 16, loss = 0.04184121
Iteration 17, loss = 0.03784997
Iteration 18, loss = 0.03543161
Iteration 19, loss = 0.03252010
Iteration 20, loss = 0.03076835
Iteration 21, loss = 0.02863340
Iteration 22, loss = 0.02632571
Iteration 23, loss = 0.02509510
Iteration 24, loss = 0.02305287
Iteration 25, loss = 0.02147379
Iteration 26, loss = 0.01971530
Iteration 27, loss = 0.01868295
Iteration 28, loss = 0.01760633
Iteration 29, loss = 0.01599809
Iteration 30, loss = 0.01460928
Iteration 31, loss = 0.01407888
Iteration 32, loss = 0.01326346
Iteration 33, loss = 0.01209922
Iteration 34, loss = 0.01178512
Iteration 35, loss = 0.01062853
Iteration 36, loss = 0.00996900
Iteration 37, loss = 0.00926535
Iteration 38, loss = 0.00960447
Iteration 39, loss = 0.00845048
Iteration 40, loss = 0.00801807
Iteration 41, loss = 0.00719797
Iteration 42, loss = 0.00680134
Iteration 43, loss = 0.00813442
Iteration 44, loss = 0.00596964
Iteration 45, loss = 0.00531117
Iteration 46, loss = 0.00592624
Iteration 47, loss = 0.00638692
Iteration 48, loss = 0.00522248
Iteration 49, loss = 0.00403879
Iteration 50, loss = 0.00550787
Iteration 51, loss = 0.00492422
Iteration 52, loss = 0.00373900
Iteration 53, loss = 0.00387110
Iteration 54, loss = 0.00414319
Iteration 55, loss = 0.00708390
Iteration 56, loss = 0.00362150
Iteration 57, loss = 0.00271743
Iteration 58, loss = 0.00318756
Iteration 59, loss = 0.00556231
Iteration 60, loss = 0.00556094
Iteration 61, loss = 0.00245348
Iteration 62, loss = 0.00209884
Iteration 63, loss = 0.00282057
Iteration 64, loss = 0.00453896
Iteration 65, loss = 0.00573164
Iteration 66, loss = 0.00271749
Iteration 67, loss = 0.00194965
Iteration 68, loss = 0.00178128
Iteration 69, loss = 0.00185539
Iteration 70, loss = 0.00253881
Iteration 71, loss = 0.00879418
Iteration 72, loss = 0.00232226
Iteration 73, loss = 0.00179282
Iteration 74, loss = 0.00166946
Iteration 75, loss = 0.00255771
Iteration 76, loss = 0.00802990
Iteration 77, loss = 0.00265355
Iteration 78, loss = 0.00176241
Iteration 79, loss = 0.00160270
Iteration 80, loss = 0.00156314
Iteration 81, loss = 0.00185063
Iteration 82, loss = 0.00928912
Iteration 83, loss = 0.00262557
Iteration 84, loss = 0.00174355
Iteration 85, loss = 0.00155519
Training loss did not improve more than tol=0.000100 for 10 consecutive epochs. Stopping.
[[ 964    0    4    0    2    3    3    2    5    1]
 [   1 1124    2    0    0    0    2    3    0    2]
 [   1    2 1004    5    3    0    2   14    4    2]
 [   0    0    4  986    0   15    1    4    9    5]
 [   1    0    1    0  954    2    5    1    5   11]
 [   5    2    0    8    2  858    4    1    7    6]
 [   3    3    6    0    6    6  937    1    5    0]
 [   1    1    6    3    6    0    0  996    4    3]
 [   2    3    5    2    1    5    4    1  932    5]
 [   2    0    0    6    8    3    0    5    3  974]]
테스트 집합에 대한 정확률은 97.28999999999999 %입니다.
```

(1) 두 모델 테스트 결과 문제 1의 정확도가 0.53% 높게 측정됨.

(2) Iteration1에서 loss는 문제 1이 0.6290, 문제 3이 0.4460으로 측정되었으나, 최종 loss는 문제 1이 0.0006, 문제 3이 0.0015로 문제 1이 더 낮게 측정됨.

(3) 결론 - Batch size 및 Hidden layer를 감소시켰을 때 정확도는 감소하고, loss는 증가하는 현상을 보임.

- 최고 성능의 모델 생성을 위해 Batch size, Hidden layer 수, 학습율, Max iteration 등을 적절하게 설정해야 함.