16장. 이미지 인식 - CNN

- MNIST 데이터 활용

```python
from keras.datasets import mnist
from keras.utils import np_utils

import numpy
import sys
import tensorflow as tf

# seed 값 설정
seed = 0
numpy.random.seed(seed)
tf.random.set_seed(3)

# MNIST데이터셋 불러오기
(X_train, Y_class_train), (X_test, Y_class_test) = mnist.load_data()

print("학습셋 이미지 수 : %d 개" % (X_train.shape[0]))
print("테스트셋 이미지 수 : %d 개" % (X_test.shape[0]))
```

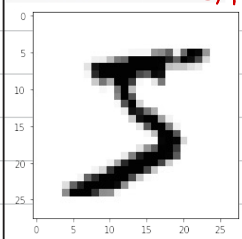
mnist 데이터

→ 이미 train, test 데이터 나눠져있음.

```
학습셋 이미지 수 : 60000 개
테스트셋 이미지 수 : 10000 개
```

```python
# 그래프로 확인
import matplotlib.pyplot as plt
plt.imshow(X_train[0], cmap='Greys')
plt.show()
```

→ 흑백으로 출력



```python
# 코드로 확인
for x in X_train[0]:
    for i in x:
        sys.stdout.write('%d\t' % i)
    sys.stdout.write('\n')
```

```
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 3 18 18 18 126 136 175 26 166 255 247 127 0 0 0 0
0 0 0 0 0 0 0 0 30 36 94 154 170 253 253 253 253 253 225 172 253 242 195 64 0 0 0 0
0 0 0 0 0 0 0 49 238 253 253 253 253 253 253 253 253 251 93 82 82 56 39 0 0 0 0 0
0 0 0 0 0 0 0 18 219 253 253 253 253 253 198 182 247 241 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 80 156 107 253 253 205 11 0 43 154 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 14 1 154 253 90 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 139 253 190 2 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 11 190 253 70 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 35 241 225 160 108 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 81 240 253 253 119 25 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 45 186 253 253 150 27 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 16 93 252 253 187 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 249 253 249 64 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 46 130 183 253 253 207 2 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 39 148 229 253 253 253 250 182 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 24 114 221 253 253 253 253 201 78 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 23 66 213 253 253 253 253 198 81 2 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 18 171 219 253 253 253 253 195 80 9 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 55 172 226 253 253 253 253 244 133 11 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 136 253 253 253 212 135 132 16 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```

⇙ 1차원배열

```python
# 차원 변환 과정
X_train = X_train.reshape(X_train.shape[0], 784)
X_train = X_train.astype('float64')
X_train = X_train / 255

X_test = X_test.reshape(X_test.shape[0], 784).astype('float64') / 255

#print(X_train[0])

# 클래스 값 확인
print("class : %d " % (Y_class_train[0]))
```

'float64' → 실수형; / 255 → 0~255 변환; → 한번에; Y_class_train[0] → 레이블값

```
class : 5
```

5 → [0, 0, 0, 0, 0, 1, 0, 0, 0, 0] 변환

⇒ 바이너리화

```python
# 바이너리화 과정
Y_train = np_utils.to_categorical(Y_class_train, 10)
Y_test = np_utils.to_categorical(Y_class_test, 10)

print(Y_train[0])
```

np_utils.to_categorical → 바이너리화 함수

```
[0. 0. 0. 0. 0. 1. 0. 0. 0. 0.]
```

- 딥러닝 기본 프레임 만들기

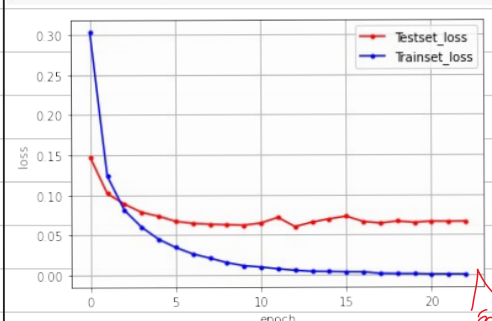
```
from keras.datasets import mnist
from keras.utils import np_utils
from keras.models import Sequential
from keras.layers import Dense
from keras.callbacks import ModelCheckpoint,EarlyStopping

import matplotlib.pyplot as plt
import numpy
import os
import tensorflow as tf

# seed 값 설정
seed = 0
numpy.random.seed(seed)
tf.random.set_seed(3)

# MNIST 데이터 불러오기
(X_train, Y_train), (X_test, Y_test) = mnist.load_data()

X_train = X_train.reshape(X_train.shape[0], 784).astype('float32') / 255
X_test = X_test.reshape(X_test.shape[0], 784).astype('float32') / 255

Y_train = np_utils.to_categorical(Y_train, 10)
Y_test = np_utils.to_categorical(Y_test, 10)

# 모델 프레임 설정
model = Sequential()
model.add(Dense(512, input_dim=784, activation='relu'))
model.add(Dense(10, activation='softmax'))

# 모델 실행 환경 설정
model.compile(loss='categorical_crossentropy',
              optimizer='adam',
              metrics=['accuracy'])

# 모델 최적화 설정
MODEL_DIR = './model/'
if not os.path.exists(MODEL_DIR):
    os.mkdir(MODEL_DIR)
modelpath="./model/{epoch:02d}-{val_loss:.4f}.hdf5"
checkpointer = ModelCheckpoint(filepath=modelpath,
                               monitor='val_loss', verbose=1,
                               save_best_only=True)
early_stopping_callback = EarlyStopping(monitor='val_loss', patience=10)
```

```
Epoch 00010: val_loss improved from 0.06278 to 0.06218, saving model to ./model/10-0.0622.hdf5
Epoch 00011: val_loss did not improve from 0.06218
Epoch 00012: val_loss did not improve from 0.06218
Epoch 00013: val_loss improved from 0.06218 to 0.06017, saving model to ./model/13-0.0602.hdf5
Epoch 00014: val_loss did not improve from 0.06017
Epoch 00015: val_loss did not improve from 0.06017
Epoch 00016: val_loss did not improve from 0.06017
Epoch 00017: val_loss did not improve from 0.06017
Epoch 00018: val_loss did not improve from 0.06017
Epoch 00019: val_loss did not improve from 0.06017
Epoch 00020: val_loss did not improve from 0.06017
Epoch 00021: val_loss did not improve from 0.06017
Epoch 00022: val_loss did not improve from 0.06017
Epoch 00023: val_loss did not improve from 0.06017
313/313 [==============================] - 1s 3ms/step - loss: 0.0665 - accuracy: 0.9826
```

```
# 모델의 실행
history = model.fit(X_train, Y_train, validation_data=(X_test, Y_test),
                    epochs=30, batch_size=200, verbose=0,
                    callbacks=[early_stopping_callback,checkpointer])

# 테스트 정확도 출력
print("\n Test Accuracy: %.4f" % (model.evaluate(X_test, Y_test)[1]))
```

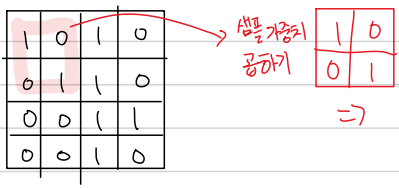
```
 Test Accuracy: 0.9826
```

```
# 테스트 셋의 오차
y_vloss = history.history['val_loss']

# 학습셋의 오차
y_loss = history.history['loss']

# 그래프로 표현
x_len = numpy.arange(len(y_loss))
plt.plot(x_len, y_vloss, marker='.', c="red", label='Testset_loss')
plt.plot(x_len, y_loss, marker='.', c="blue", label='Trainset_loss')

# 그래프에 그리드를 주고 레이블을 표시
plt.legend(loc='upper right')
# plt.axis([0, 20, 0, 0.35])
plt.grid()
plt.xlabel('epoch')
plt.ylabel('loss')
plt.show()
```



- 컨볼루션 신경망(CNN)

: 입력된 이미지에서 다시 한번 특징을 추출하기 위해 커널(슬라이딩 윈도)을 도입하는 기법



⇒

2	1	1
0	2	2
0	1	1

컨볼루션 (합성곱)
: 더욱 정교한 특징 추출 가능!

… 컨볼루션 n개 생성
↳ Conv2D()

```
# 컨볼루션 신경망의 설정
model = Sequential()
model.add(Conv2D(32, kernel_size=(3, 3), input_shape=(28, 28, 1),
                 activation='relu'))
model.add(Conv2D(64, (3, 3), activation='relu'))
```

32: 컨볼을 몇개적용할지
(3,3): 커널의 크기
input_shape: 맨처음을 입력값 (행, 열, 색상)

- 맥스풀링 MaxPooling2D()

```
model.add(MaxPooling2D(pool_size=2))
```

: 정해진 구역 안에서 최댓값을 뽑아냄.

- 평균풀링

: " " 평균값을 뽑아냄.

- 드롭아웃: 과적합을 효과적으로 피하는 기법

↳ 은닉층에 배치된 노드 중 일부를 임의로 꺼주는 것

```
model.add(Dropout(0.25))
```

25%의 노드를 끔

펼쳐진 배열 변경

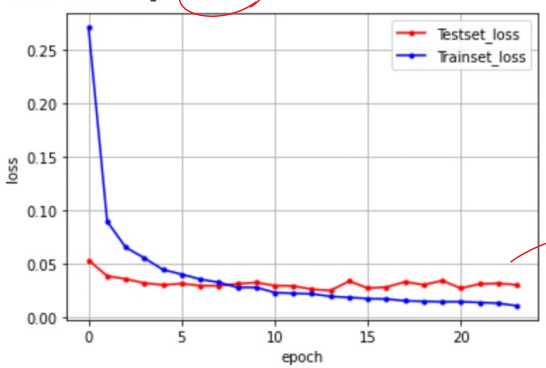
완전연결된 기본층에 연결

```
model.add(Flatten())
model.add(Dense(128,  activation='relu'))
model.add(Dropout(0.5))
model.add(Dense(10, activation='softmax'))

model.compile(loss='categorical_crossentropy',
              optimizer='adam',
              metrics=['accuracy'])
```

*GPU환경에서 하기

<결과>

Test Accuracy: 0.9929 → 향상됨



→ 향상됨

<도식도>