Deep Learning
Deep Neural Network

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Deep Learning

CNN(2)
Convolutional Neural Networks

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CNN, Convolution Neural Network
Case study

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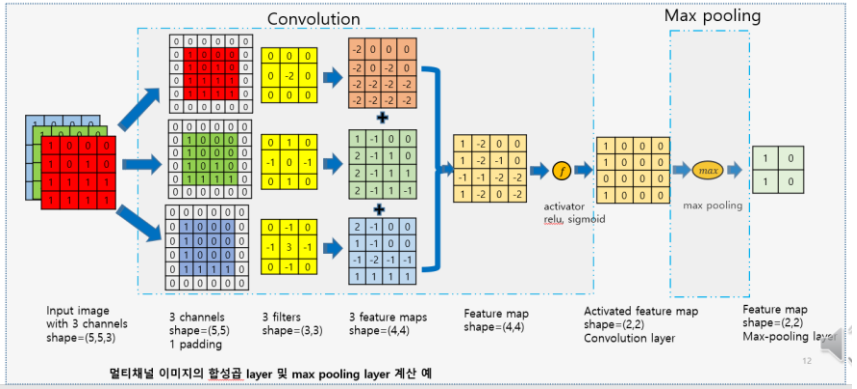
- 5.1 CNN 구성예



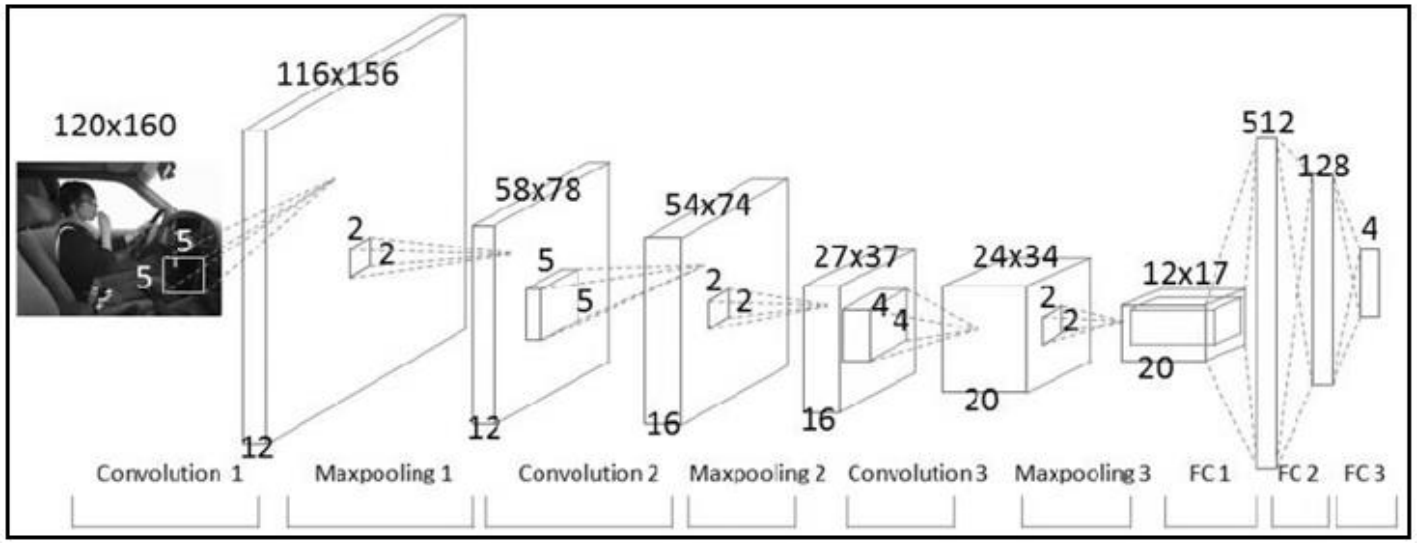
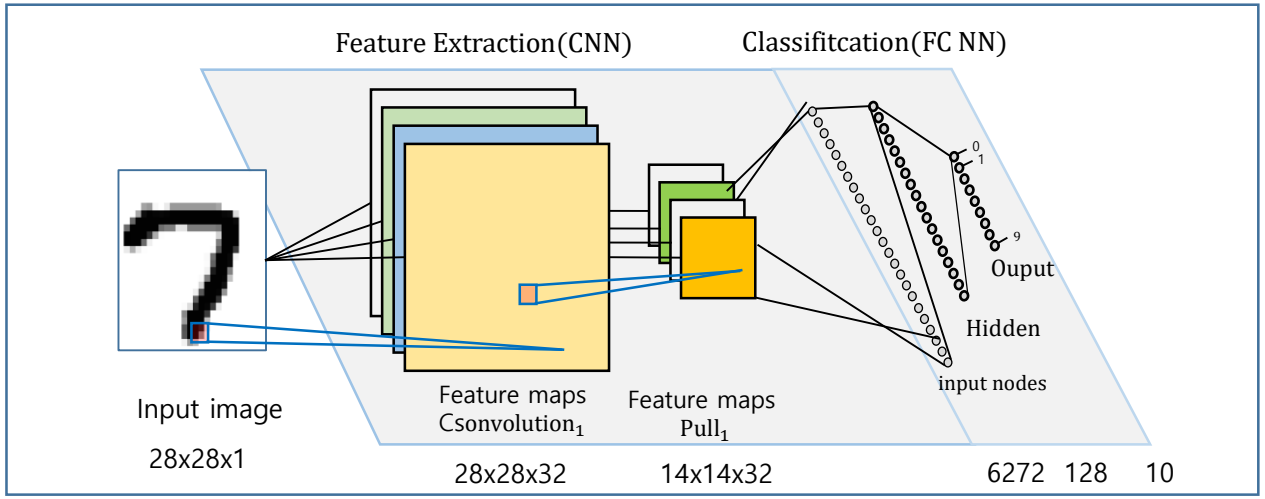


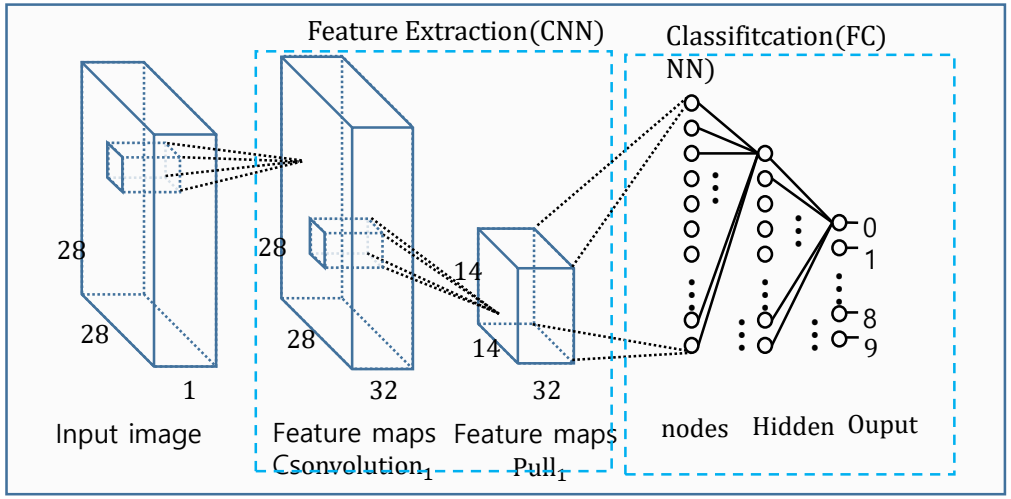
그림 8: 전형적인 CNN, 출처: https://www.researchgate.net/figure/Architecture-of-our-unsupervised-CNN-Network-contains-three-stages-each-of-which_283433254

```
model = Sequential()
model.add(Conv2D(12, kernel_size=(5, 5), activation='relu', input_shape=(120, 160, 1)))      #116x156
model.add(MaxPooling2D(pool_size=(2, 2)))                                                    #  58x78
model.add(Conv2D(16, kernel_size=(5, 5), activation='relu'))          #54x74
model.add(MaxPooling2D(pool_size=(2, 2)))                            #   27x37
model.add(Conv2D(20, kernel_size=(4, 4), activation='relu'))          # 24x34
model.add(MaxPooling2D(pool_size=(2, 2)))                            #   12x17
model.add(Flatten())                                                 #12x17=204
model.add(Dense(128, activation='relu'))
model.add(Dense(4, activation='softmax'))
```

5.2 Mnist digit classifier with 1 Convolution layer

- 1 Convolution NN



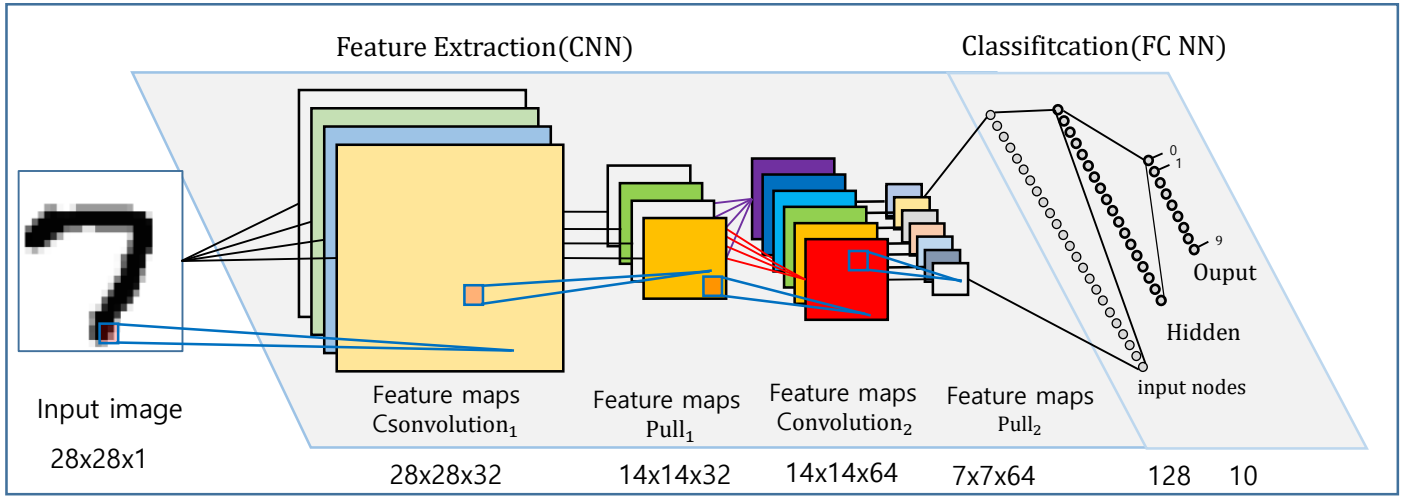


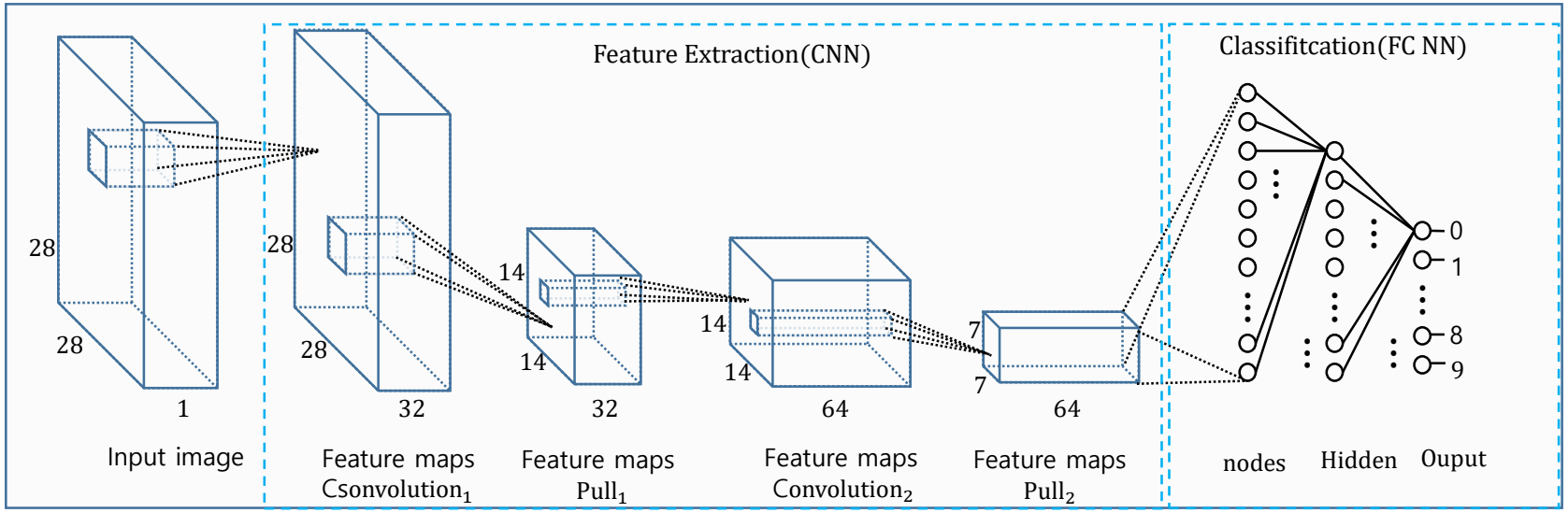

```
model = Sequential()
model.add(Conv2D(32, kernel_size=(3, 3), activation='relu',input_shape=input_shape)) #26,26,32
model.add(MaxPooling2D(pool_size=(2, 2)))                                             #14,14,32
model.add(Dropout(0.25))
model.add(Flatten())                                                                  #6272 = 14*14*32
model.add(Dense(128, activation='relu'))                                              #128
model.add(Dropout(0.5))
model.add(Dense(num_classes, activation='softmax'))                                   #10
```

```
Epoch 10/12
60000/60000 [==============================] - 4s 73us/step - loss: 0.0459 - acc: 0.9852 - val_loss: 0.0402 - val_acc: 0.9865
Epoch 11/12
60000/60000 [==============================] - 5s 78us/step - loss: 0.0431 - acc: 0.9859 - val_loss: 0.0373 - val_acc: 0.9881
Epoch 12/12
60000/60000 [==============================] - 5s 75us/step - loss: 0.0389 - acc: 0.9873 - val_loss: 0.0357 - val_acc: 0.9880
Test loss: 0.035724134841622436
Test accuracy: 0.988
```

5.2 Mnist digit classifier with deep Convolution layers

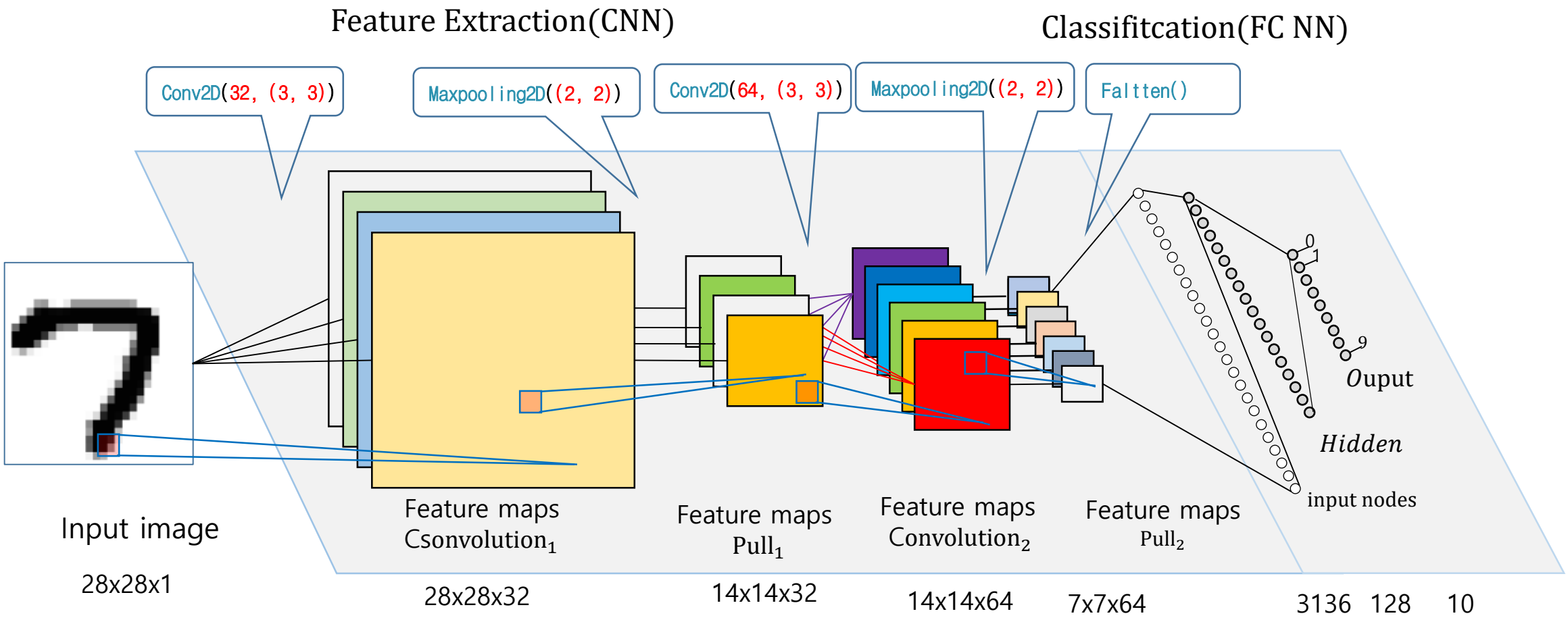
- 2 Convolution NN





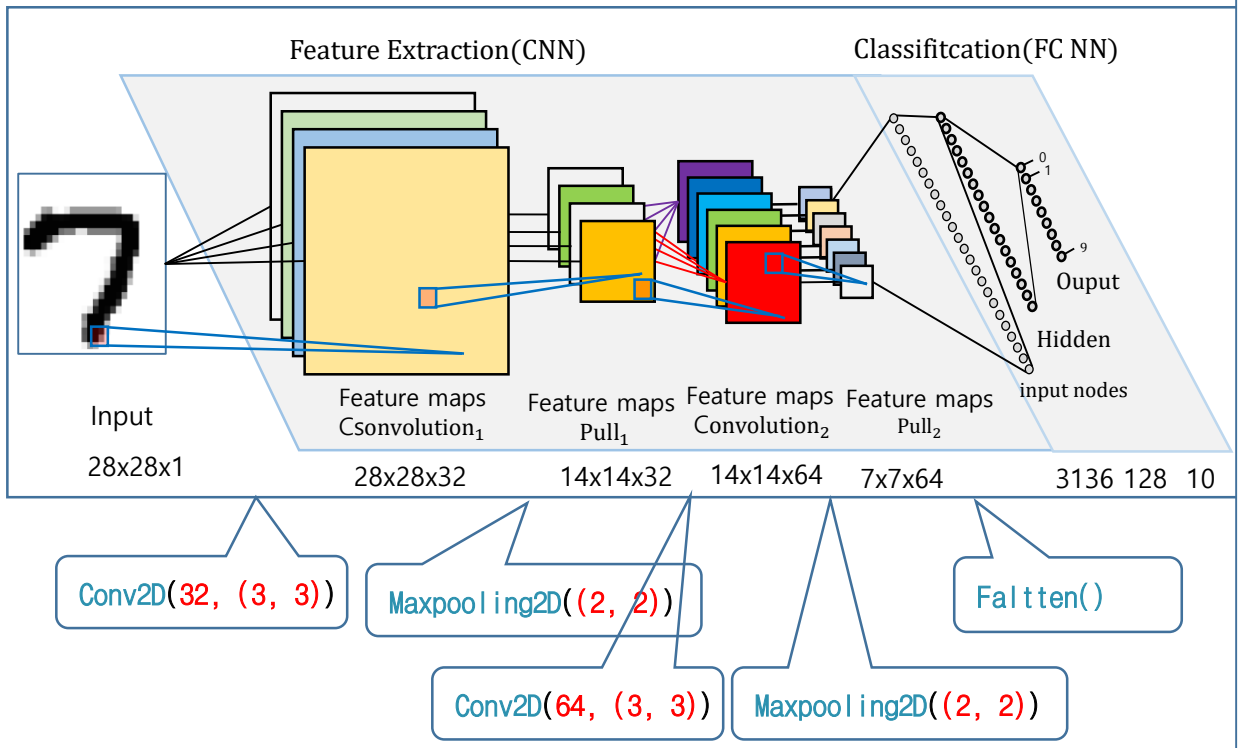
5.2 Mnist digit classifier with deep Convolution layers

- 2 Convolution NN



5.2 Mnist digit classifier with deep Convolution layers

- 2 Convolution NN




```
model = Sequential()
#convolution layer
model.add(Conv2D(32, kernel_size=(3, 3), activation='relu',
                 input_shape=input_shape))                    #28,28,32
model.add(MaxPooling2D(pool_size=(2, 2)))                     #14,14,32
model.add(Dropout(0.25))
model.add(Conv2D(64, kernel_size=(3, 3), activation='relu')) #14,14,64
model.add(MaxPooling2D(pool_size=(2, 2)))                     #7,7,64
model.add(Dropout(0.25))


model.add(Flatten())                                          #3136 = 7*7*64
model.add(Dense(128, activation='relu'))                      #128
model.add(Dropout(0.5))
model.add(Dense(num_classes, activation='softmax'))           #10
```

5.2 Mnist digit classifier with deep Convolution layers

```
from keras.datasets import mnist
from keras.models import Sequential
from keras.layers import Dense, Dropout, Flatten
from keras.layers import Conv2D, MaxPooling2D
from keras.utils import to_categorical as ohe

batch_size = 128; num_classes = 10; epochs = 12

# input image dimensions
img_rows, img_cols = 28, 28
input_shape=(img_rows, img_cols,1)

# loead mnist image and train and test datasets
(x_train, y_train), (x_test, y_test) = mnist.load_data()
x_train = x_train.reshape(x_train.shape[0], img_rows, img_cols,
                  1).astype(float)/255
x_test  = x_test.reshape(x_test.shape[0],   img_rows, img_cols,
                  1).astype(float)/255
print('x_train shape:{}  y_train shape:{} ', x_train.shape,y_train.shape)
print('x_test shape :{}  y_test shape :{} ', x_test.shape,y_test.shape)

# convert label  to one_hot_encoding(label,10)
y_train_ohe = ohe(y_train, num_classes)
y_test_ohe  = ohe(y_test, num_classes)
```

```
model = Sequential()
#convolution layer
model.add(Conv2D(32, kernel_size=(3, 3), activation='relu',
                  input_shape=input_shape))              #26,26,32
model.add(MaxPooling2D(pool_size=(2, 2)))                #14,14,32
model.add(Dropout(0.25))

model.add(Conv2D(64, kernel_size=(3, 3), activation='relu')) #14,14,64
model.add(MaxPooling2D(pool_size=(2, 2)))                #7,7,64
model.add(Dropout(0.25))

model.add(Flatten())                                     #3136 = 7*7*64
model.add(Dense(128, activation='relu'))                 #128
model.add(Dropout(0.25))
model.add(Dense(num_classes, activation='softmax')) #10

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

model.fit(x_train, y_train_ohe, validation_data=(x_test, y_test_ohe),
                  batch_size=batch_size, epochs=epochs, verbose=1)

score = model.evaluate(x_test, y_test_ohe, verbose=0)
print('Test loss:', score[0])
print('Test accuracy:', score[1])
```

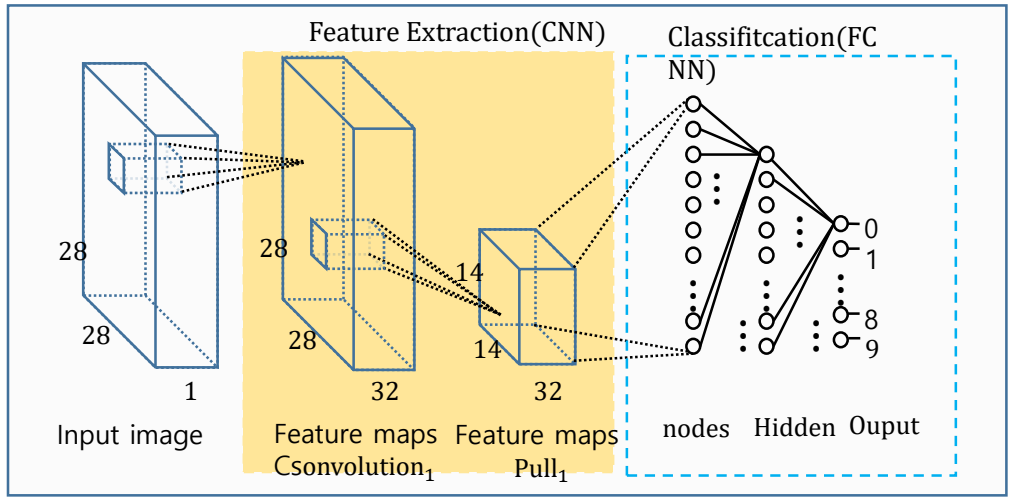
5.2 Mnist digit classifier with deep Convolution layers

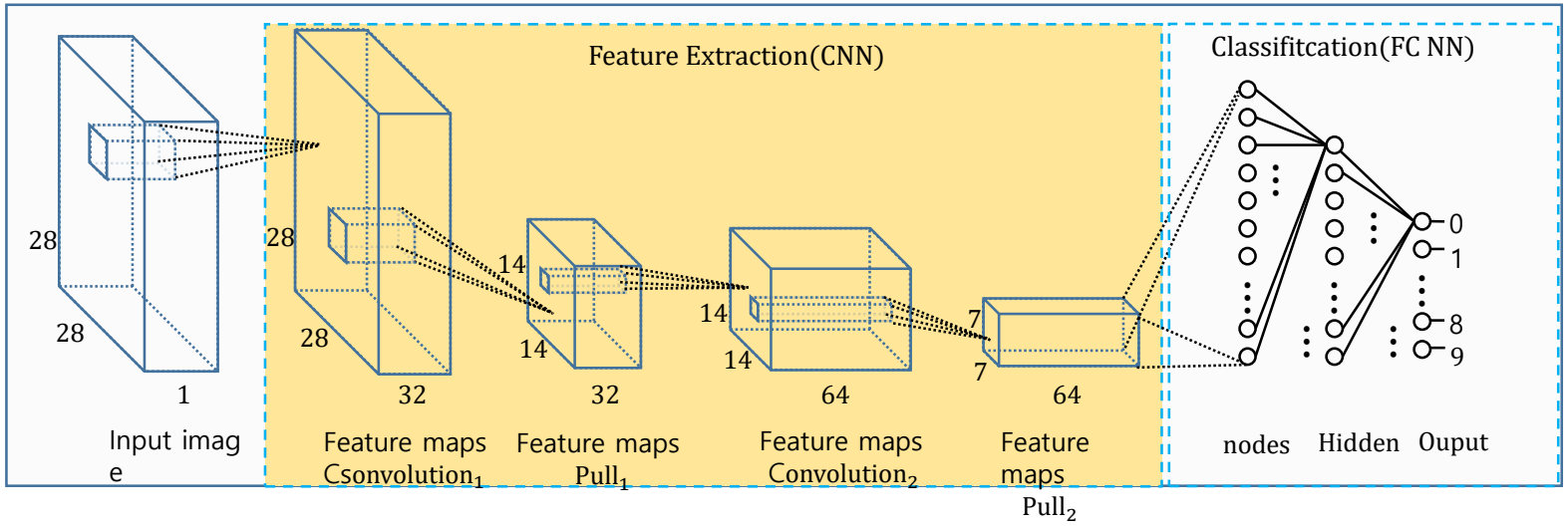
```
from keras.data
from keras.mod
from keras.laye
from keras.laye
from keras.utils

batch_size = 1

# input image
img_rows, img
input_shape=(i

# loead mnist
(x_train, y_train
x_train = x_trai
                1)
x_test  = x_test
                1)
print('x_train sh
print('x_test sha

# convert labe
y_train = ohe(y
y_test  = ohe(y_test, num_classes)
```

```
C:₩Program Files (x86)₩Microsoft Visual Studio₩Shared₩Python36_64₩python.exe
Using TensorFlow backend.
x_train shape:{}  y_train shape:{}  (60000, 28, 28, 1) (60000,)
x_test shape :{}  y_test shape :{}  (10000, 28, 28, 1) (10000,)
Train on 60000 samples, validate on 10000 samples
Epoch 1/12
60000/60000 [==============================] - 10s 166us/step - loss: 0.2960 - acc: 0.9077 - val_loss: 0.0724 - val_acc: 0.9766
Epoch 2/12
60000/60000 [==============================] - 5s 87us/step - loss: 0.0897 - acc: 0.9727 - val_loss: 0.0442 - val_acc: 0.9859
Epoch 3/12
60000/60000 [==============================] - 5s 88us/step - loss: 0.0655 - acc: 0.9799 - val_loss: 0.0331 - val_acc: 0.9882
Epoch 4/12
60000/60000 [==============================] - 5s 88us/step - loss: 0.0526 - acc: 0.9835 - val_loss: 0.0307 - val_acc: 0.9896
Epoch 5/12
60000/60000 [==============================] - 5s 89us/step - loss: 0.0474 - acc: 0.9855 - val_loss: 0.0278 - val_acc: 0.9906
Epoch 6/12
60000/60000 [==============================] - 5s 88us/step - loss: 0.0409 - acc: 0.9871 - val_loss: 0.0245 - val_acc: 0.9912
Epoch 7/12
60000/60000 [==============================] - 5s 90us/step - loss: 0.0359 - acc: 0.9886 - val_loss: 0.0249 - val_acc: 0.9916
Epoch 8/12
60000/60000 [==============================] - 5s 89us/step - loss: 0.0340 - acc: 0.9889 - val_loss: 0.0250 - val_acc: 0.9912
Epoch 9/12
60000/60000 [==============================] - 5s 91us/step - loss: 0.0299 - acc: 0.9904 - val_loss: 0.0235 - val_acc: 0.9917
Epoch 10/12
60000/60000 [==============================] - 5s 79us/step - loss: 0.0271 - acc: 0.9914 - val_loss: 0.0232 - val_acc: 0.9924
Epoch 11/12
60000/60000 [==============================] - 5s 91us/step - loss: 0.0254 - acc: 0.9915 - val_loss: 0.0207 - val_acc: 0.9932
Epoch 12/12
60000/60000 [==============================] - 5s 87us/step - loss: 0.0255 - acc: 0.9917 - val_loss: 0.0203 - val_acc: 0.9929
Test loss: 0.020317405389965 28
Test accuracy: 0.9929
```

```
score = model.evaluate(x_test, y_test, verbose=0)
print('Test loss:', score[0])
print('Test accuracy:', score[1])
```

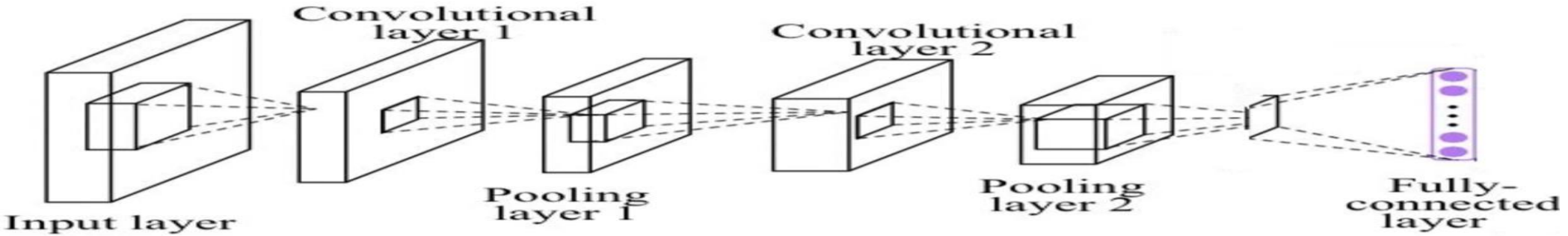
5.2 Mnist digit classifier with deep Convolution layers





5.3 exercise

- 다음 CNN구조로 minist image 인식 시스템을 구현화여 99.3%이상의 인식률을 얻을 수 있음을 확인 하시오.



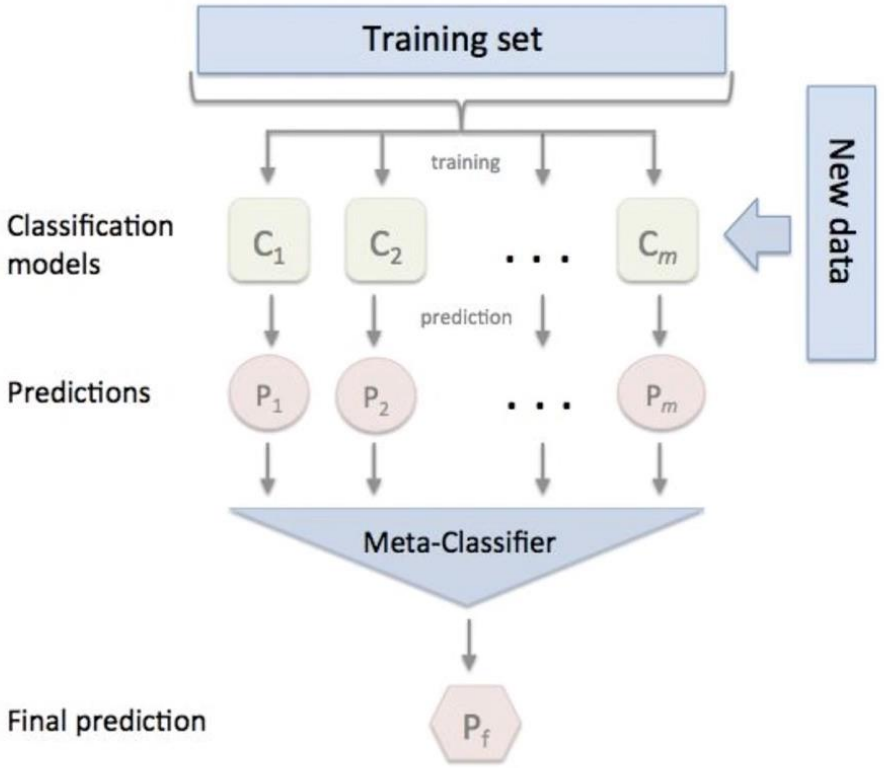
784: 28x28x1 28x28x32 14x14x32 14x14x64 7x7x64 : 3136

```
Epoch 12/12
60000/60000 [==============================
Test loss: 0.020794622257165 61
Test accuracy: 0.9935
Press any key to continue . . .
```

5.4 CIFAR-10

- CIFAR-10 데이터세트(Canadian Institute For Advanced Research)
  - 일반적으로 머신 러닝 및 컴퓨터 비전 알고리즘을 훈련시키는 데 사용되는 이미지 모음입니다.
  - 10 가지 클래스로 구성된 60,000 개의 32x32 컬러 이미지가 포함되어 있습니다.
  - 10 가지 다른 클래스는 비행기, 자동차, 새, 고양이, 사슴, 개, 개구리, 말, 배 및 트럭을 나타냅니다. 각 클래스마다 6,000 개의 이미지가 있습니다.
- [ConvNetJS demo: training on CIFAR-10]
  - http://cs.Stanford.edu/people/karpathy/convnetjs/demo/cifar10.html

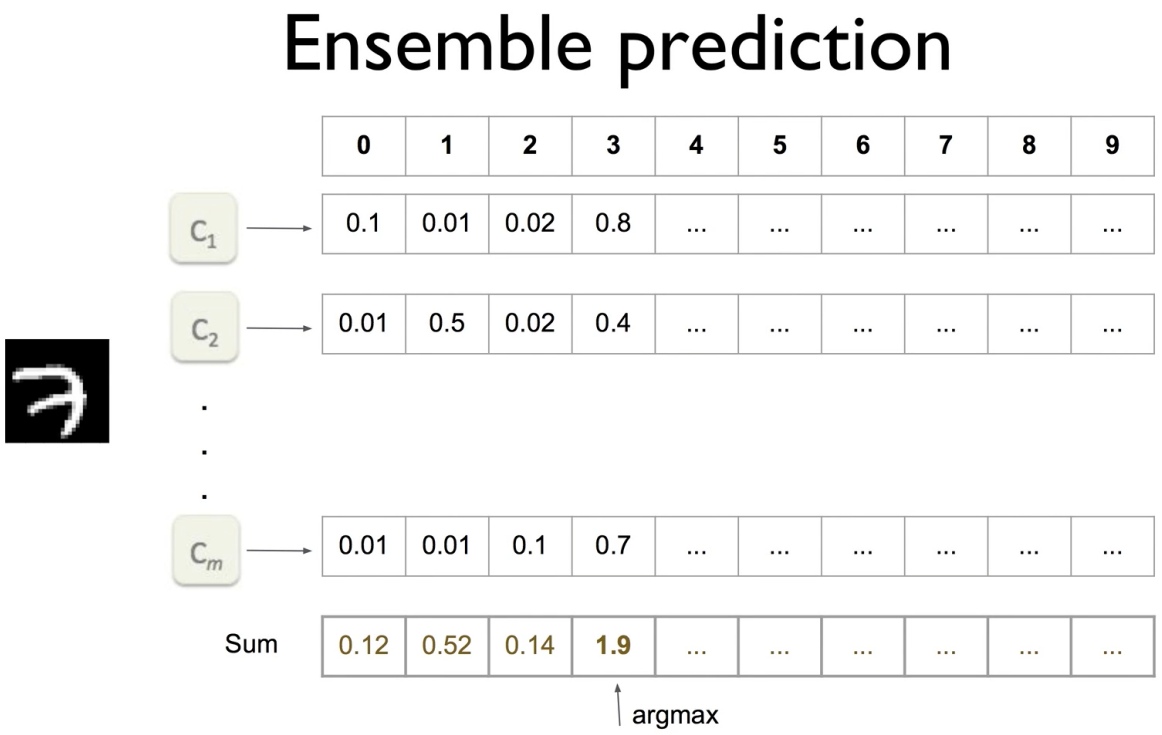
5.5 Ensemble



$$P_1 = C_1.predict(y_{train})$$
$$P_2 = C_2.predict(y_{train})$$
$$\vdots$$
$$P_n = C_n.predict(y_{train})$$

http://rasbt.github.io/mlxtend/user_guide/classifier/StackingClassifier/

5.5 Ensemble




```
import numpy as np

predictions=np.zeros(10,dtype=float)
for i, model in enumerate(models):
            acc=model.evaluate(X_train,Y_train_ohe)
            print(' model[{}] acc:{}'.format(i,acc))
            p=mode.predict(X_train) #p=[0.1, 0.3, 0.2, .W0.5,,,]
            predictions =predictions+p  #[0..9] =[0..9]+[0..9]

ensenble_predicts=np.equal(np.argmax(predictions,1),
            np.argmax(Y_train_ohe,1))
ensenble_accuracy=ensenble_predicts.mean()
print('Ensenble accuracy : ',ensenble_accuracy)
```

Recap

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2. CNN, Convolution Neural Network
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    3. filter, kernel, stride, feature map and activation map
    4. Padding
    5. pooling layer
    6. 출력 레이어의 크기 계산
    7. Fully Connected Layer(FC layer)
4. Case study
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    2. AlexNet
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    5. Sentence Classification
    6. AlphaGo
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    1. CNN 구성예
    2. Mnist digit classifier with CNN
    3. Exercise
    4. ConvNetJS demo: training on CIFAR-10
    5. Exnsenble

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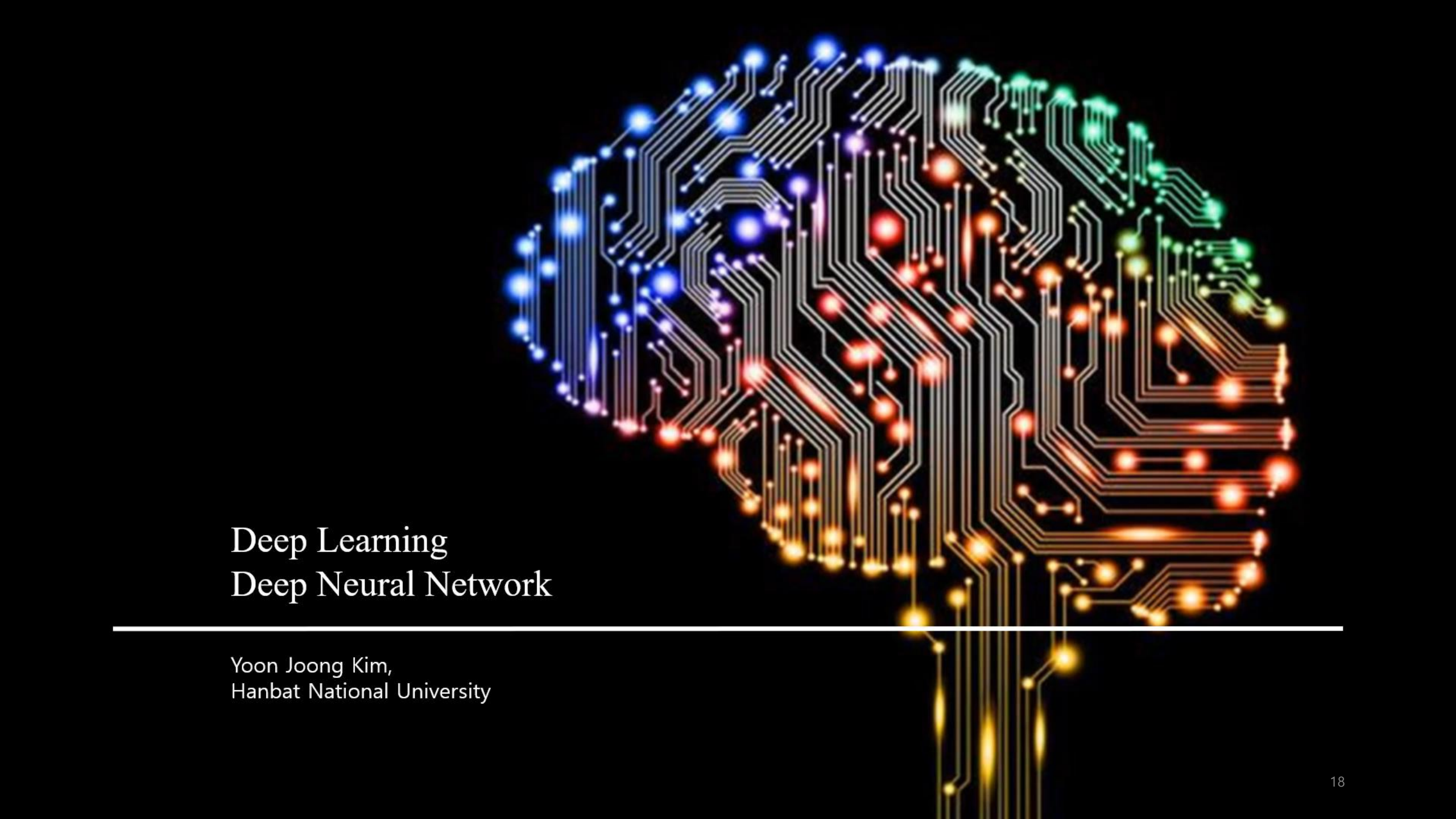

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