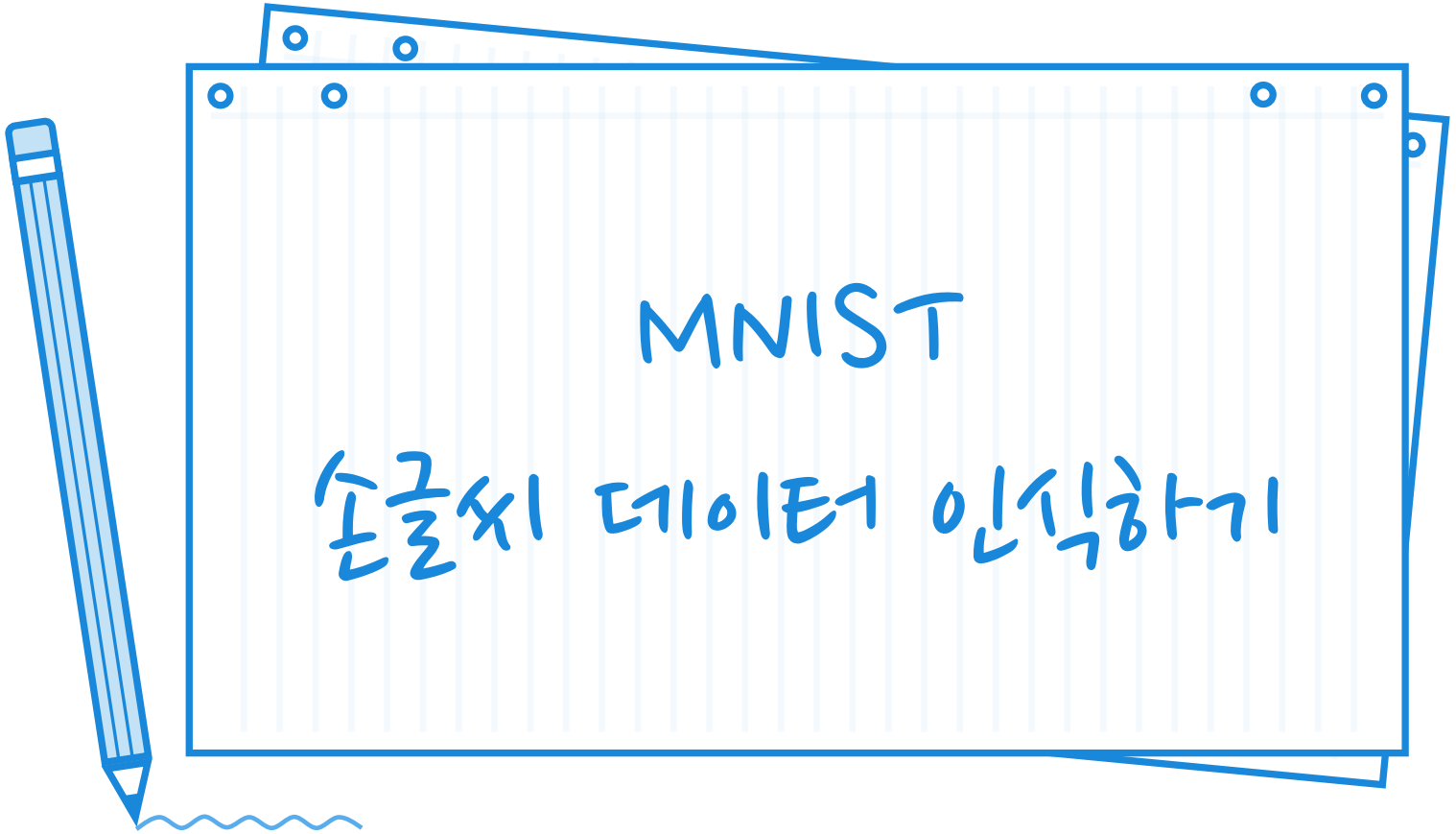
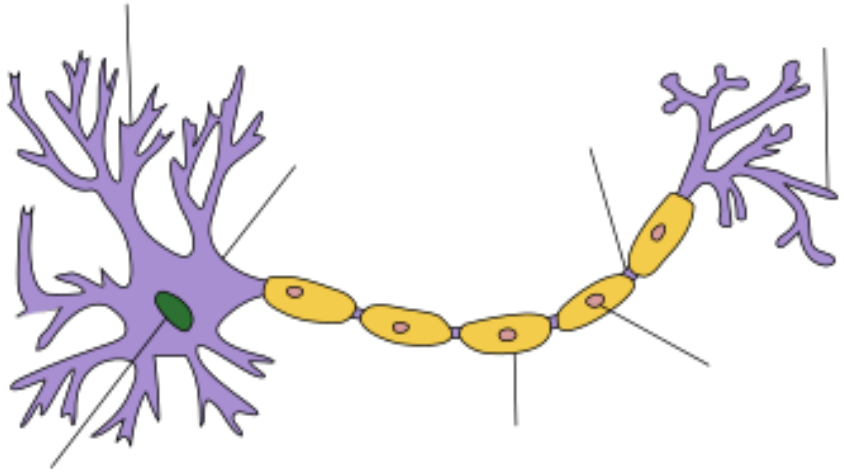
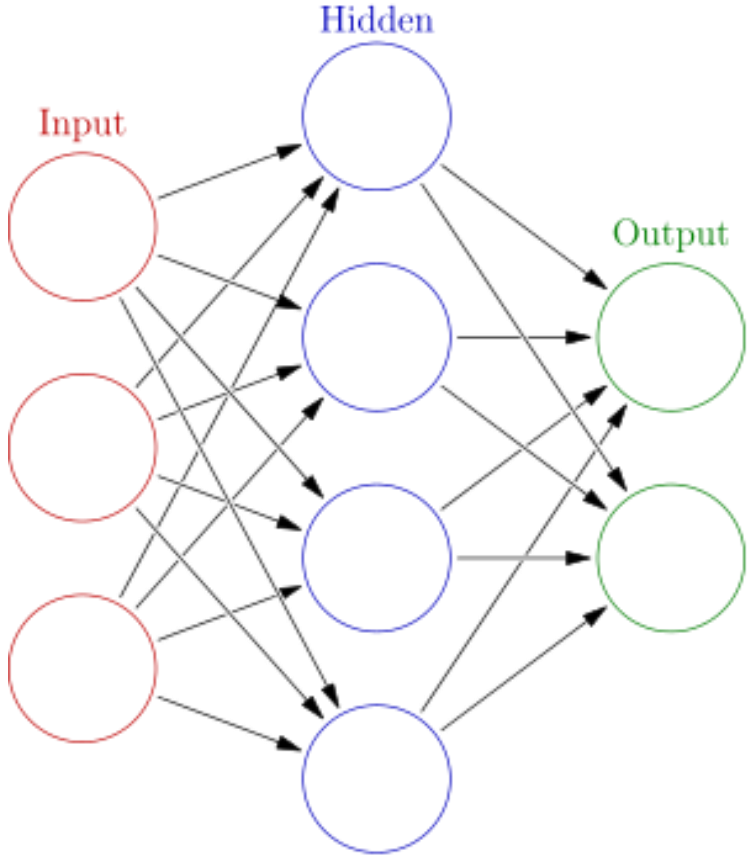

MNIST
손글씨 데이터 인식하기

MNIST 손글씨 데이터 인식하기



neuron



artificial neural network

MNIST 손글씨 데이터 인식하기

```
import numpy
# scipy.special for the sigmoid function expit()
import scipy.special
# library for plotting arrays
import matplotlib.pyplot
# ensure the plots are inside this notebook, not an external window
%matplotlib inline
```

```
# helper to load data from PNG image files
import imageio
# glob helps select multiple files using patterns
import glob
```

MNIST 손글씨 데이터 인식하기

```
# neural network class definition
class neuralNetwork:


    # initialise the neural network
    def __init__(self, inputnodes, hiddennodes, outputnodes, learningrate):
        # set number of nodes in each input, hidden, output layer
        self.inodes = inputnodes
        self.hnodes = hiddennodes
        self.onodes = outputnodes

        # link weight matrices, wih and who
        # weights inside the arrays are w_i_j, where link is from node i to node j in the next layer
        # w11 w21
        # w12 w22 etc
        self.wih = numpy.random.normal(0.0, pow(self.inodes, -0.5), (self.hnodes, self.inodes))
        self.who = numpy.random.normal(0.0, pow(self.hnodes, -0.5), (self.onodes, self.hnodes))

        # learning rate
        self.lr = learningrate

        # activation function is the sigmoid function
        self.activation_function = lambda x: scipy.special.expit(x)

        pass
```

MNIST 손글씨 데이터 인식하기

```
# train the neural network
def train(self, inputs_list, targets_list):
    # convert inputs list to 2d array
    inputs = numpy.array(inputs_list, ndmin=2).T
    targets = numpy.array(targets_list, ndmin=2).T

    # calculate signals into hidden layer
    hidden_inputs = numpy.dot(self.wih, inputs)
    # calculate the signals emerging from hidden layer
    hidden_outputs = self.activation_function(hidden_inputs)

    # calculate signals into final output layer
    final_inputs = numpy.dot(self.who, hidden_outputs)
    # calculate the signals emerging from final output layer
    final_outputs = self.activation_function(final_inputs)

    # output layer error is the (target - actual)
    output_errors = targets - final_outputs
    # hidden layer error is the output_errors, split by weights, recombined at hidden nodes
    hidden_errors = numpy.dot(self.who.T, output_errors)

    # update the weights for the links between the hidden and output layers
    self.who += self.lr * numpy.dot((output_errors * final_outputs * (1.0 - final_outputs)), numpy.transpose(hidden_outputs))

    # update the weights for the links between the input and hidden layers
    self.wih += self.lr * numpy.dot((hidden_errors * hidden_outputs * (1.0 - hidden_outputs)), numpy.transpose(inputs))

    pass
```

1. 주어진 학습 데이터에 대해 결과 값을 계산
2. 계산한 결과 값을 실제의 값과 비교하고 이 차이를 이용해 가중치를 업데이트

(실제 값 - 계산 값)

MNIST 손글씨 데이터 인식하기

```
# query the neural network
def query(self, inputs_list):
    # convert inputs list to 2d array
    inputs = numpy.array(inputs_list, ndmin=2).T

    # calculate signals into hidden layer
    hidden_inputs = numpy.dot(self.wih, inputs)
    # calculate the signals emerging from hidden layer
    hidden_outputs = self.activation_function(hidden_inputs)

    # calculate signals into final output layer
    final_inputs = numpy.dot(self.who, hidden_outputs)
    # calculate the signals emerging from final output layer
    final_outputs = self.activation_function(final_inputs)

    return final_outputs
```

MNIST 손글씨 데이터 인식하기

```
# number of input, hidden and output nodes
input_nodes = 784
hidden_nodes = 200
output_nodes = 10

# learning rate
learning_rate = 0.1

# create instance of neural network
n = neuralNetwork(input_nodes,hidden_nodes,output_nodes, learning_rate)
```

MNIST 손글씨 데이터 인식하기

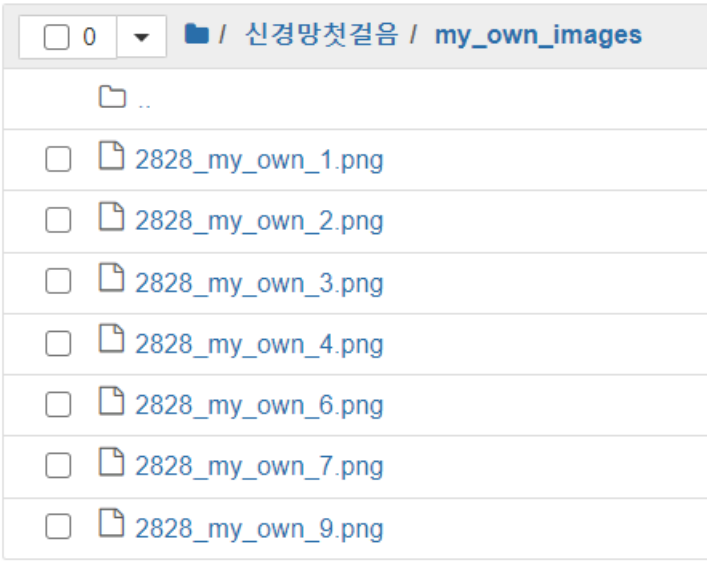
```
# load the mnist training data CSV file into a list
training_data_file = open("mnist_dataset/mnist_train.csv", 'r')
training_data_list = training_data_file.readlines()
training_data_file.close()
```

MNIST 손글씨 데이터 인식하기

```
# epochs is the number of times the training data set is used for training
epochs = 10

for e in range(epochs):
    # go through all records in the training data set
    for record in training_data_list:
        # split the record by the ',' commas
        all_values = record.split(',')
        # scale and shift the inputs
        inputs = (numpy.asfarray(all_values[1:]) / 255.0 * 0.99) + 0.01
        # create the target output values (all 0.01, except the desired label which is 0.99)
        targets = numpy.zeros(output_nodes) + 0.01
        # all_values[0] is the target label for this record
        targets[int(all_values[0])] = 0.99
        n.train(inputs, targets)
        pass
    pass
```

MNIST 손글씨 데이터 인식하기

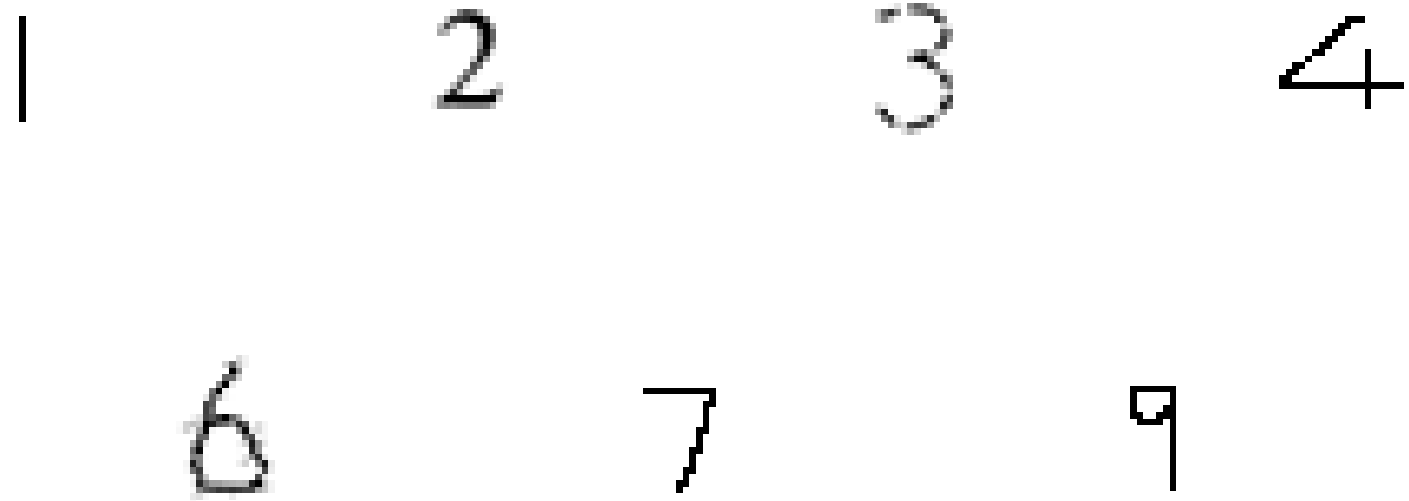
```
# our own image test data set
our_own_dataset = []

# load the png image data as test data set
for image_file_name in glob.glob('my_own_images/2828_my_own_?.png'):

    # use the filename to set the correct label
    label = int(image_file_name[-5:-4])

    # load image data from png files into an array
    print ("loading ... ", image_file_name)
    img_array = imageio.imread(image_file_name, as_gray=True)

    # reshape from 28x28 to list of 784 values, invert values
    img_data  = 255.0 - img_array.reshape(784)

    # then scale data to range from 0.01 to 1.0
    img_data = (img_data / 255.0 * 0.99) + 0.01
    print(numpy.min(img_data))
    print(numpy.max(img_data))

    # append label and image data  to test data set
    record = numpy.append(label,img_data)
    our_own_dataset.append(record)

    pass
```



MNIST 손글씨 데이터 인식하기

```
# test the neural network with our own images

# record to test
item = 5

# plot image
matplotlib.pyplot.imshow(our_own_dataset[item][1:].reshape(28,28), cmap='Greys', interpolation='None')

# correct answer is first value
correct_label = our_own_dataset[item][0]
# data is remaining values
inputs = our_own_dataset[item][1:]

# query the network
outputs = n.query(inputs)
print (outputs)

# the index of the highest value corresponds to the label
label = numpy.argmax(outputs)
print("network says ", label)
# append correct or incorrect to list
if (label == correct_label):
    print ("match!")
else:
    print ("no match!")
    pass
```

MNIST 손글씨 데이터 인식하기



MNIST 손글씨 데이터 인식하기

```
# number of input, hidden and output nodes
input_nodes = 784
hidden_nodes = 200
output_nodes = 10

# learning rate
learning_rate = 0.1
```

```
epochs = 10
```

```
# calculate the performance score, the fraction of correct answers
scorecard_array = numpy.asarray(scorecard)
print ("performance = ", scorecard_array.sum() / scorecard_array.size)
```

```
performance =  0.9739
```


Thank You