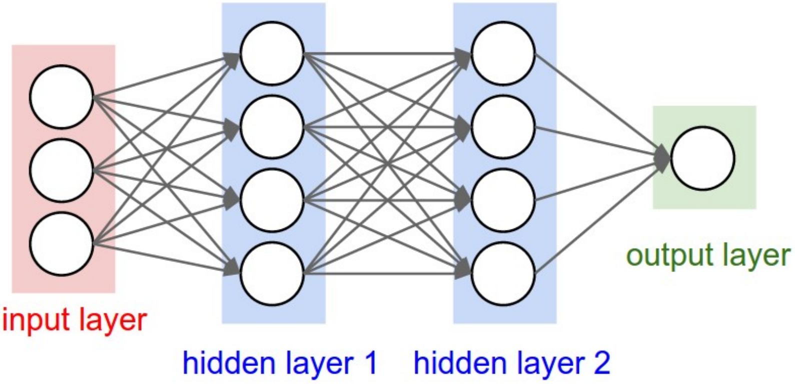
Neural Network Example

Xây dựng neural network với hai tầng ẩn (hidden layer). Các trọng số và mối liên hệ giữa các tầng ẩn được thiết lập và cài đặt bằng việc sử dụng API của thư viện PyTorch

Neural Network Overview



MNIST Dataset Overview

In [1]:
```
from __future__ import absolute_import, division, print_function

import torch
import torch.nn as nn
import torch.nn.functional as F
import torch.optim as optim
import torchvision
import torchvision.transforms as transforms
from torch.autograd import Variable
import numpy as np
```

In [2]:
```
# Chuẩn bị dữ liệu
from tensorflow.keras.datasets import mnist
(x_train, y_train), (x_test, y_test) = mnist.load_data()
# Chuyển đổi sang định dạng float32.
x_train, x_test = np.array(x_train, np.float32), np.array(x_test, np.float3
# Chuẩn hóa ảnh từ from [0, 255] to [0, 1].
x_train, x_test = x_train / 255., x_test / 255.
x_train, x_test, y_train, y_test = torch.from_numpy(x_train), torch.from_nu
```

```
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-
datasets/mnist.npz (https://storage.googleapis.com/tensorflow/tf-keras-da
tasets/mnist.npz)
11493376/11490434 [==============================] - 0s 0us/step
11501568/11490434 [==============================] - 0s 0us/step
```

In [20]:

```
# MNIST dataset parameters.
num_classes = 10 # total classes (0-9 digits).
num_features = 784 # data features (img shape: 28*28).

# Network parameters.
n_hidden_1 = 128 # 1st layer number of neurons.
# n_hidden_2 = 256 # 2nd layer number of neurons.
```

In [3]:

```
batch_size = 16
```

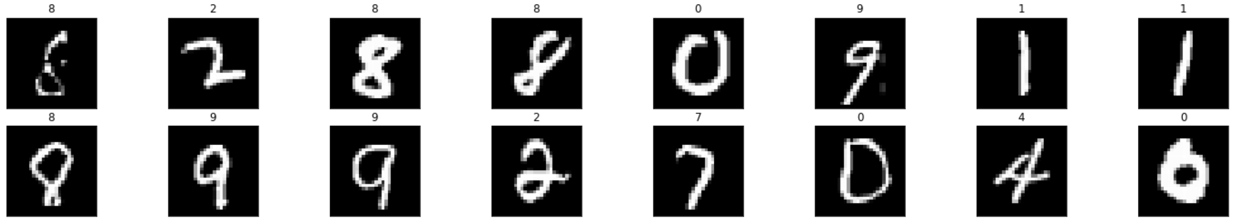
In [4]:

```
trainloader = []
for (i,j) in zip(x_train, y_train):
    trainloader.append([i,j])
trainloader = torch.utils.data.DataLoader(trainloader, shuffle=True, batch_

testloader = []
for (i,j) in zip(x_test, y_test):
    testloader.append([i,j])
testloader = torch.utils.data.DataLoader(testloader, shuffle=True, batch_si
```

Hiển thị một vài ví dụ

In [5]:

```
import matplotlib.pyplot as plt
%matplotlib inline

dataiter = iter(trainloader)
images, labels = dataiter.next()
images = images.numpy()

# hiển thị dữ liệu theo từng batch và nhãn tương ứng
fig = plt.figure(figsize=(25, 4))
for idx in np.arange(batch_size):
    ax = fig.add_subplot(2, batch_size/2, idx+1, xticks=[], yticks=[])
    ax.imshow(np.squeeze(images[idx]), cmap='gray')
    ax.set_title(str(labels[idx].item()))
```



In [21]:

```
import torch.nn as nn
import torch.nn.functional as F

## định nghĩa mạng
class MLPModel(nn.Module):
    def __init__(self):
        super(MLPModel, self).__init__()
        self.fc1 = nn.Linear(num_features, n_hidden_1)
        # linear layer (n_hidden -> hidden_2)
        self.fc2 = nn.Linear(n_hidden_1, num_classes)

    def forward(self, x):
        # chuyển từ định dạng ma trận thành vector
        x = x.view(-1, 28 * 28)
        # add hidden layer, with relu activation function
        x = F.relu(self.fc1(x))
        x = F.relu(self.fc2(x))
        return x

# initialize the NN
model = MLPModel()
print(model)
```

```
MLPModel(
  (fc1): Linear(in_features=784, out_features=128, bias=True)
  (fc2): Linear(in_features=128, out_features=10, bias=True)
)
```

In [22]:

```
import torch.optim as optim
# trong hàm loss cross entropy đã áp dụng hàm soft max cho vector đầu ra
criterion = nn.CrossEntropyLoss()
optimizer = optim.SGD(model.parameters(), lr=0.01)
```

In [23]:

```
def accuracy():
    correct = 0
    total = 0
    # since we're not training, we don't need to calculate the gradients fo
    with torch.no_grad():
        for data in testloader:
            images, labels = data
            # calculate outputs by running images through the network
            outputs = model(images)
            # the class with the highest energy is what we choose as predic
            _, predicted = torch.max(outputs.data, 1)
            total += labels.size(0)
            correct += (predicted == labels).sum().item()

    return correct/total
```

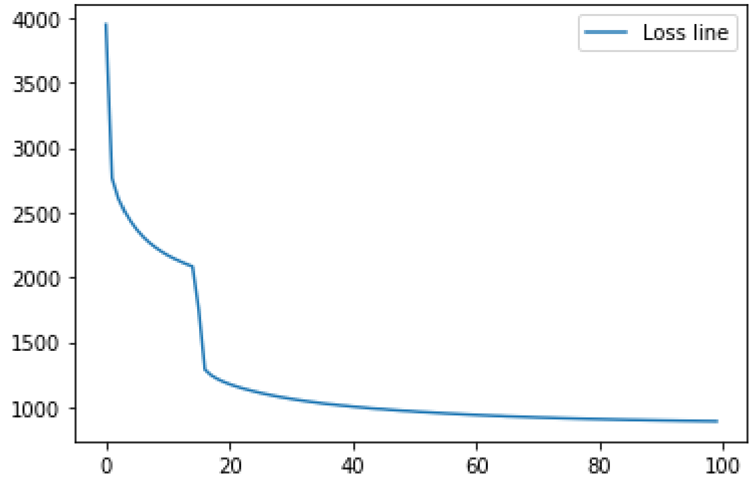
In [24]:

```
losses = []
for epoch in range(100):  # loop over the dataset multiple times

    running_loss = 0.0
    for i, data in enumerate(trainloader, 0):
        # get the inputs; data is a list of [inputs, labels]
        inputs, labels = data

        # zero the parameter gradients
        optimizer.zero_grad()

        # forward + backward + optimize
        outputs = model(inputs)
        loss = criterion(outputs, labels)
        loss.backward()
        optimizer.step()

        # print statistics
        running_loss += loss.item()
    losses.append(running_loss)
    if epoch % 10 == 9:
        print('Iteration: %d, accuracy: %.3f' %(epoch + 1, accuracy()))

print('Finished Training')
```

```
Iteration: 10, accuracy: 0.773
Iteration: 20, accuracy: 0.878
Iteration: 30, accuracy: 0.882
Iteration: 40, accuracy: 0.883
Iteration: 50, accuracy: 0.885
Iteration: 60, accuracy: 0.886
Iteration: 70, accuracy: 0.886
Iteration: 80, accuracy: 0.885
Iteration: 90, accuracy: 0.886
Iteration: 100, accuracy: 0.886
Finished Training
```

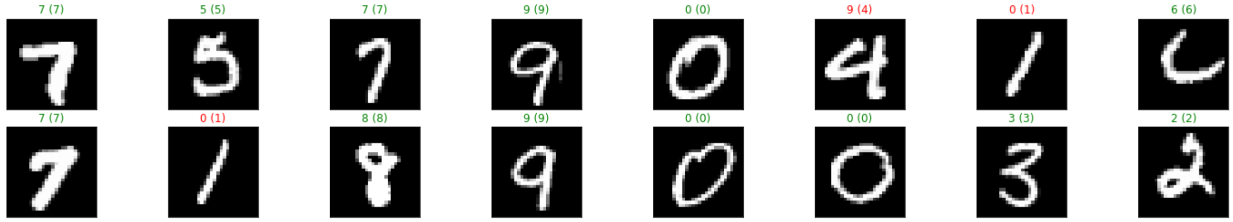
In [25]:

```
# Biểu đồ biểu diễn độ biến thiên của hàm mất mát qua các vòng lặp
plt.plot([i for i in range(len(losses))], losses, label='Loss line')
# plt.plot(X, np.array(W * X + b), label='Fitted line')
plt.legend()
plt.show()
```



In [24]:

```
# obtain one batch of test images
dataiter = iter(testloader)
images, labels = dataiter.next()

# get sample outputs
output = model(images)
# convert output probabilities to predicted class
_, preds = torch.max(output, 1)
# prep images for display
images = images.numpy()

# plot the images in the batch, along with predicted and true labels
fig = plt.figure(figsize=(25, 4))
for idx in np.arange(batch_size):
    ax = fig.add_subplot(2, batch_size/2, idx+1, xticks=[], yticks=[])
    ax.imshow(np.squeeze(images[idx]), cmap='gray')
    ax.set_title("{} ({})".format(str(preds[idx].item()), str(labels[idx].i
                 color=("green" if preds[idx]==labels[idx] else "red"))
```



In [ ]: