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PyTorch: a framework for deep learning

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http://www.labri.fr/perso/vle

Contents

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1. Overview

2. PyTorch's main packages

3. Use PyTorch to implement a Deep N-Layer Neural Network

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Overview

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- A deep learning framework with Tensor computation and GPU acceleration
- Easy convert from other Python packages: Numpy, SciPy, Cython,…
- Free framework, distributed under BSD-style licensed
- Install pytorch: https://pytorch.org/get-started/locally/

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Overview - PyTorch's component

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Component	Description
Torch	A Tensor library like Numpy with strong GPU support
Torch.autograd	Provides all differentiable Tensor operations in torch
Torch.nn	Library for neural networks
Torch.multiprocessing	Python multiprocessing
Torch.utils	DataLoader, Trainer and other utility functions
Torch.legacy	Legacy code which has inherited from Torch for backward propagation

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Contents

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1. Overview

2. **PyTorch's main packages**

3. Use PyTorch to implement a Deep N-Layer Neural Network

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PyTorch's main packages – Torch.Autograd

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- The central of all neural network in PyTorch
- Provide automatic differentiation for all operations on Tensors
- Enable to compute the gradient automatically (`.requires_grad` attribute)
- Use function `.backward()` to call the computation for gradient

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PyTorch's main packages – Torch.nn

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- Contains all components to build a neural network
- **`nn.Module`** is a base class for all neural network
- Your neural network should inherited from this class. It must contain:
  - The layers
  - A method **`forward`** to return the **`output`**

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Contents

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1. Overview

2. PyTorch's main packages

3. **Use PyTorch to implement a Deep N-Layer Neural Network**

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Use PyTorch to design a NN

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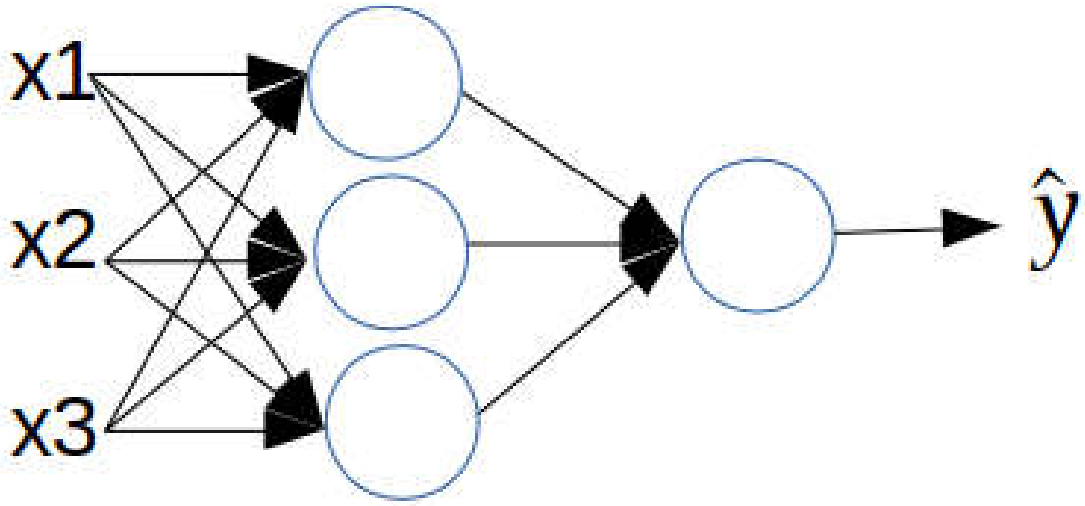
Lets we consider a neural network with one hidden layer



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Use PyTorch to design a NN

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Process:

- Define the neural network with learnable parameters
- Define (choose) the loss function
- Iterate over training data to train the network model, calculate the forward and backward propagation
- Update the parameters

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Step 1: Define neural network

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- Inherited from `nn.Module` class
- Implement the `forward` method

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


class Net(nn.Module):

    def __init__(self):
        super(Net, self).__init__()
        # define the layers of the network
        self.layer1 = nn.Linear(3,4)
        self.layer2 = nn.Linear(4,1)

    def forward(self, x):
        x = F.relu(self.layer1(x)) # use ReLU function for layer 1
        x = F.sigmoid(self.layer2(x)) # use Sigmoid function for layer 2
        return x

net = Net()
print(net)
```


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Step 2: Choose the loss function

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- PyTorch provides several different loss functions
- Distributed in nn package

- *For example*: We use Cross-Entropy loss.

```
criterion = nn.CrossEntropyLoss() # declare a CrossEntropy loss function
# Calculate the loss, where output is prediction of network, target is ground truth
loss = criterion(output, target)
print(loss)
```


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Step 3: Calculate the backward propagation

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- Clear the existing gradient (if it exists)
- Call the function: `loss.backward()` to run backward process.

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Step 4: Update the parameters

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For example, the simplest rule is used Stochastic Gradient Descent (SGD)

$$weight = weight - learning_{rate} * gradient$$

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Step 4: Update the parameters

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`Torch.optim` package

Implement different update rules which are used in Neural Networks such as SGD, Nesterov-SGD, Adam, …

```
1  import torch.optim as optim
2
3  # create your optimizer
4  optimizer = optim.SGD(net.parameters(), lr=0.01)
5
6  # in your training loop:
7  optimizer.zero_grad()   # zero the gradient buffers
8
9  # 1. Train the model (to predict the output)
10 # 2. Compute the loss
11 # 3. Calculate the gradient
12
13 optimizer.step()    # Update the parameters
```


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Step 5: Train the network

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Loop over data iterator, and feed the inputs to the network and optimize.

```
for epoch in range(2):  # loop over the dataset multiple times

    running_loss = 0.0
    for i, data in enumerate(trainloader, 0):
        # get the inputs
        inputs, labels = data

        # zero the parameter gradients
        optimizer.zero_grad()

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


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Summary

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- PyTorch framework
- How to use PyTorch to design a Neural Network
- How to use PyTorch to design other variants architectures of deep learning?

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