Lab1
Backpropagation and Basic Pytorch

Outline

- Backpropagation
- Dataset
- Task1
- Task2
- Regulations

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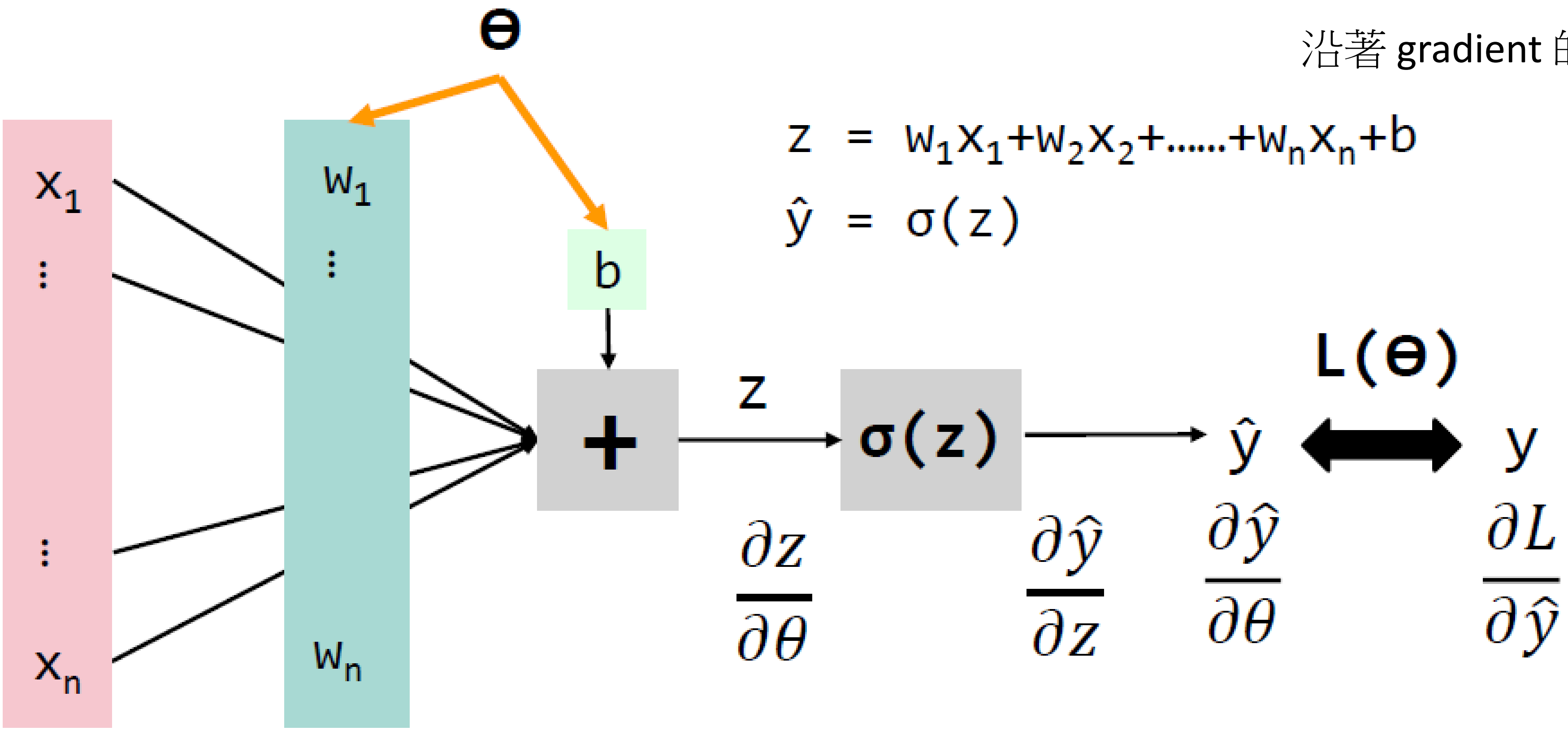
Back Propagation


Θ
x_1
⋮
⋮
x_n
w_1
⋮
w_n
b
+
z
σ(z)
ŷ
L(Θ)
y
$\frac{\partial z}{\partial \theta}$
$\frac{\partial \hat{y}}{\partial z}$
$\frac{\partial \hat{y}}{\partial \theta}$
$\frac{\partial L}{\partial \hat{y}}$

$$z = w_1x_1+w_2x_2+\ldots\ldots+w_nx_n+b$$

$$\hat{y} = \sigma(z)$$

沿著 gradient 的反方向走 Learning rate

$$\theta = \theta - \eta\frac{\partial L}{\partial \theta}$$

$$\frac{\partial L}{\partial \theta} = \frac{\partial L}{\partial \hat{y}}\frac{\partial \hat{y}}{\partial \theta} = \boxed{\frac{\partial L}{\partial \hat{y}}}\boxed{\frac{\partial \hat{y}}{\partial z}}\frac{\partial z}{\partial \theta}$$

Chain rule (又叫 Back propagation 倒傳遞)

Source: Lecture slide chapter 2

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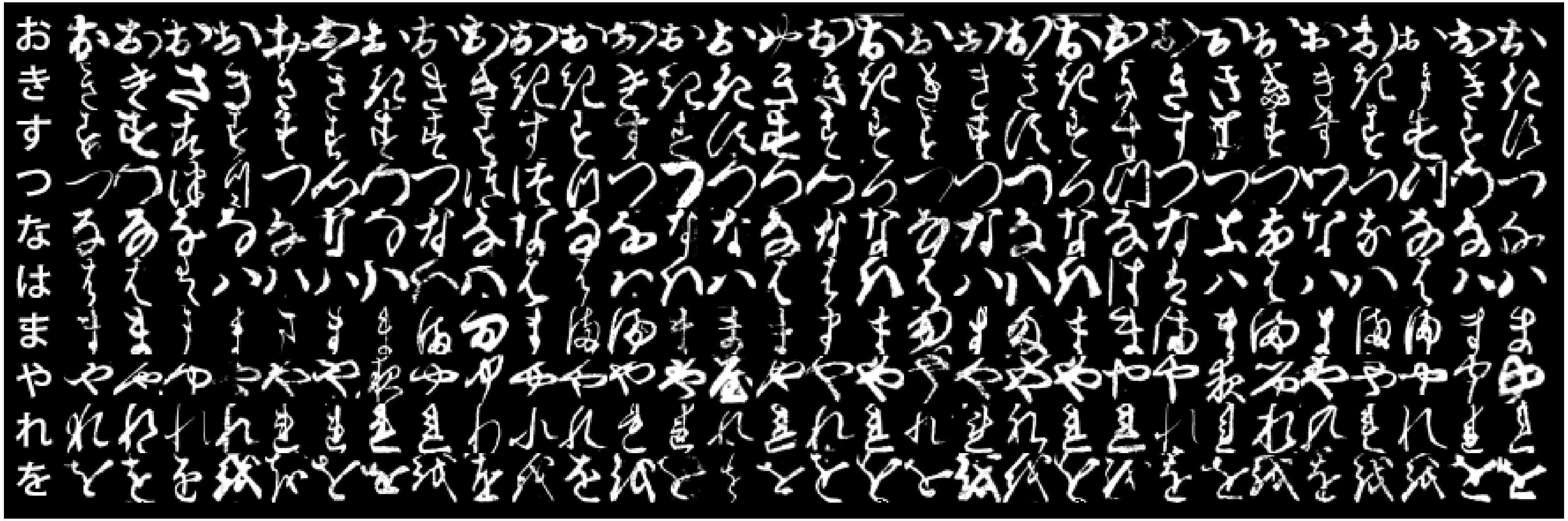
Dataset: Kuzushiji-MNIST

- Image Classification
- Classes: 10, image size =28*28 grayscale
- Training: 50,000   Validation: 10,000   Testing: 10,000



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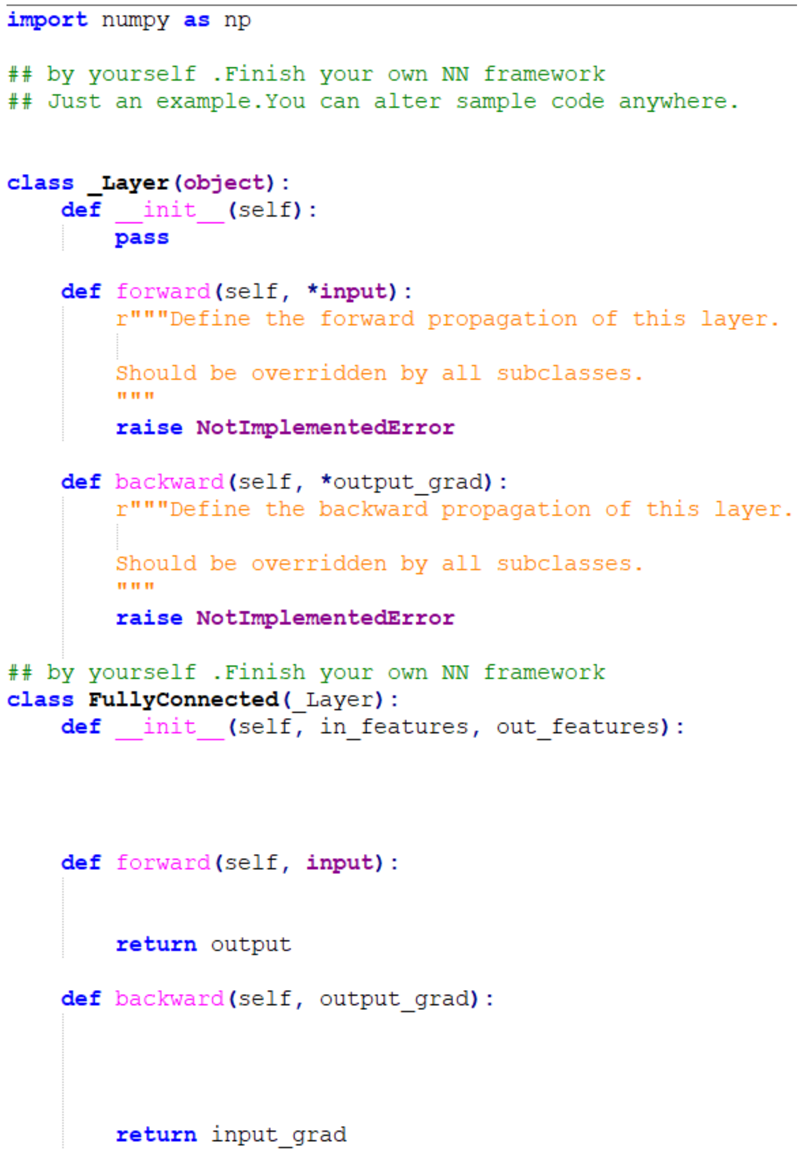
Task 1 – NN from scratch

- You need to build a neural network from scratch
  - layer.py : Define the functions of each layer (include forward & backward)
  - network.py : Build a network with layers you defined in layer.py
  - Lab1_task1.ipynb : Decide the hyperparameters and run your code
  - The settings for training have been written by TA
- For task1, you are not allowed to use deep learning frameworks.

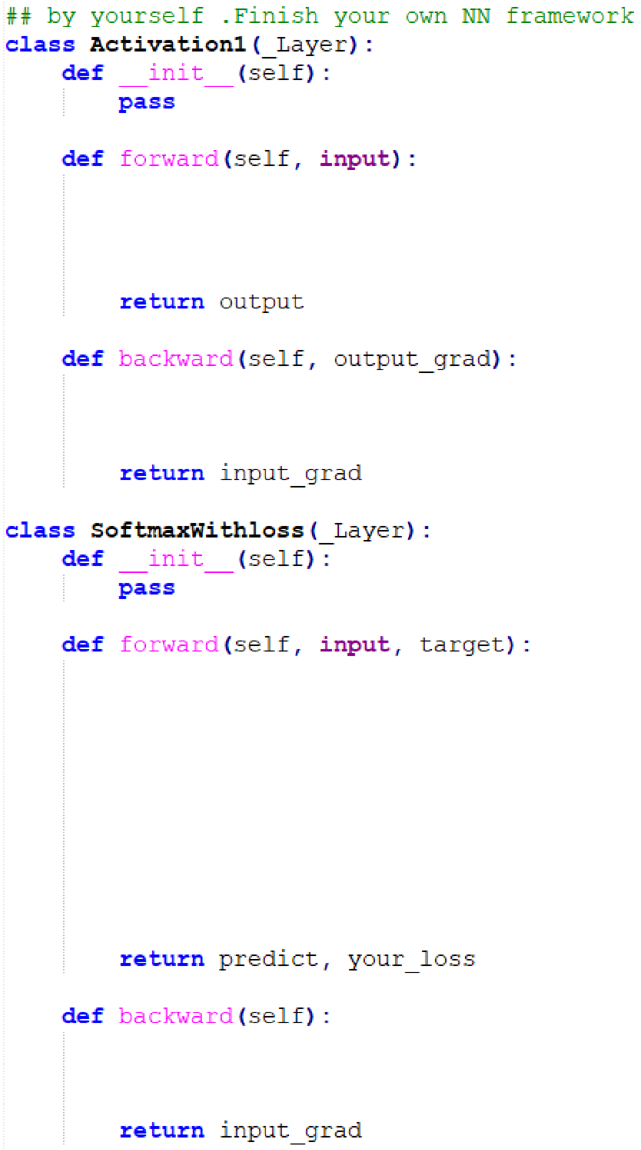
Package available in Task 1

- numpy
- pandas
- ~~Scikit-learn~~
- ~~Pytorch, tensorflow, keras~~

model/layer.py

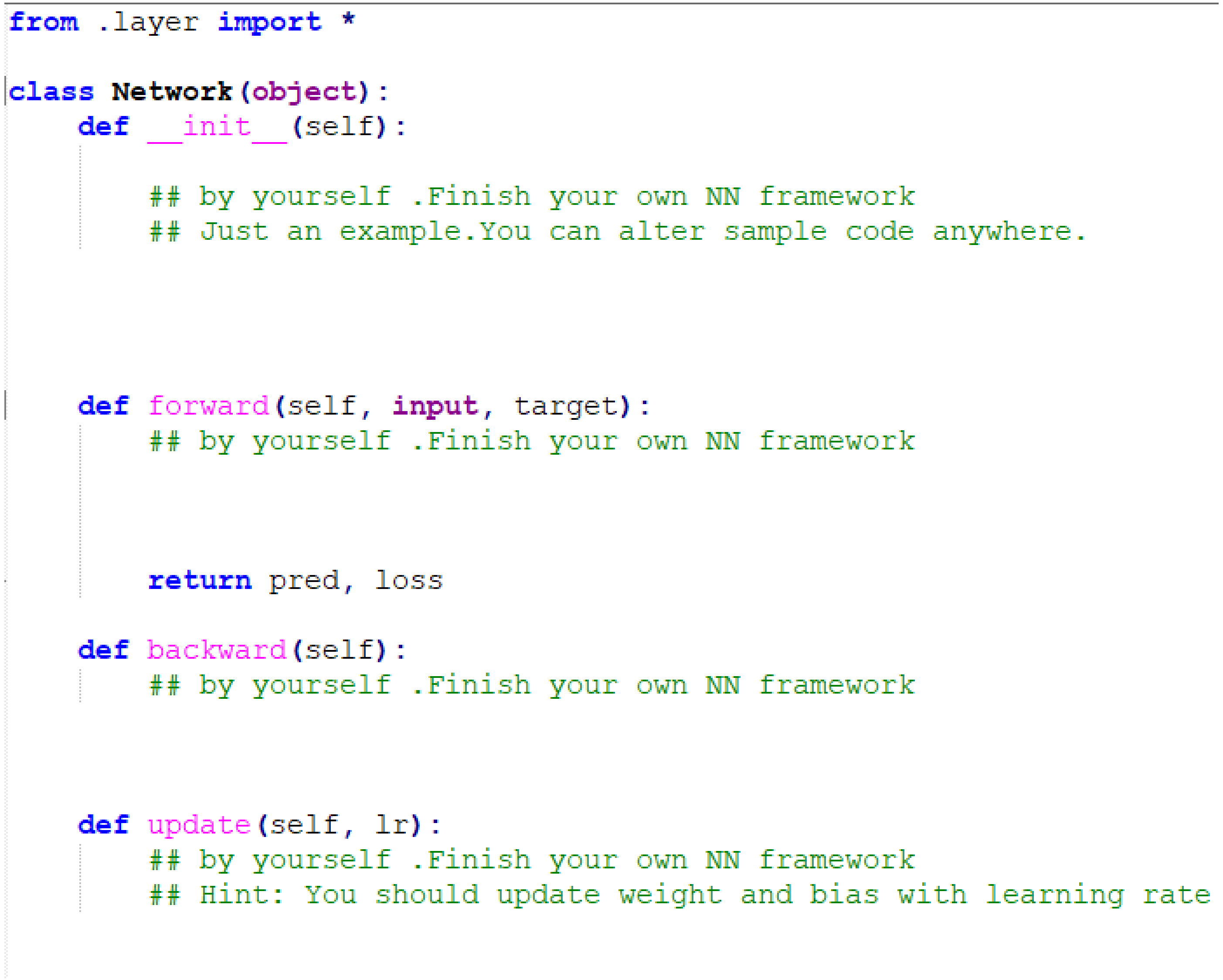


```
import numpy as np

## by yourself .Finish your own NN framework
## Just an example.You can alter sample code anywhere.


class _Layer(object):
    def __init__(self):
        pass

    def forward(self, *input):
        r"""Define the forward propagation of this layer.

        Should be overridden by all subclasses.
        """
        raise NotImplementedError

    def backward(self, *output_grad):
        r"""Define the backward propagation of this layer.

        Should be overridden by all subclasses.
        """
        raise NotImplementedError

## by yourself .Finish your own NN framework
class FullyConnected(_Layer):
    def __init__(self, in_features, out_features):




    def forward(self, input):


        return output

    def backward(self, output_grad):




        return input_grad
```



```
## by yourself .Finish your own NN framework
class Activation1(_Layer):
    def __init__(self):
        pass

    def forward(self, input):




        return output

    def backward(self, output_grad):



        return input_grad

class SoftmaxWithloss(_Layer):
    def __init__(self):
        pass

    def forward(self, input, target):










        return predict, your_loss

    def backward(self):



        return input_grad
```

model/network.py

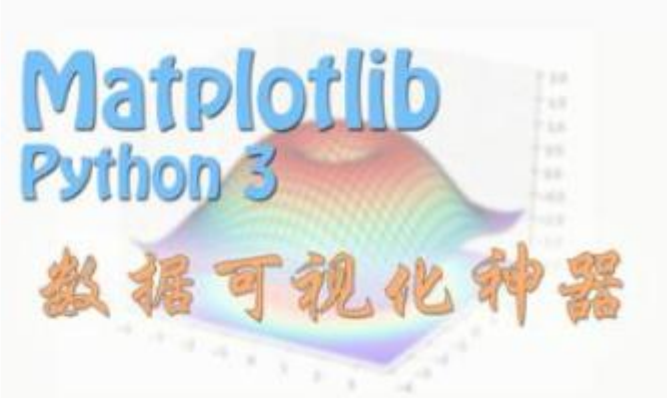


```
from .layer import *

class Network(object):
    def __init__(self):

        ## by yourself .Finish your own NN framework
        ## Just an example.You can alter sample code anywhere.




    def forward(self, input, target):
        ## by yourself .Finish your own NN framework



        return pred, loss

    def backward(self):
        ## by yourself .Finish your own NN framework



    def update(self, lr):
        ## by yourself .Finish your own NN framework
        ## Hint: You should update weight and bias with learning rate
```

Task1 Overview

- You need to be familiar with jupyter python and useful library
  - numpy, pandas, matplot, etc…

- If you are not familiar with python, I strongly recommend you to see 莫凡’s python tutorial. (or other online materials)
  - https://morvanzhou.github.io/



Source: 2023 DL Lab1

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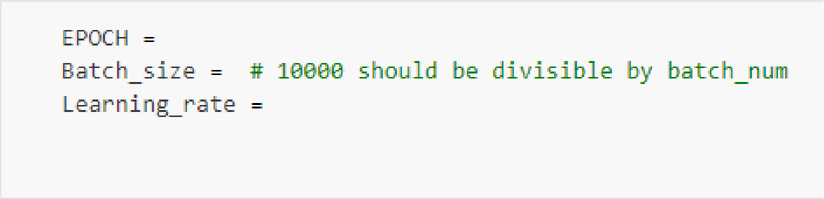
Task2 – Build neural network using PyTorch

- In Lab1_task2.ipynb
  - You need to rewrite the network you built in Task 1 using PyTorch
  - The settings for training have been written by TA
  - Network should be the same as Task 1
  - You may only use pytorch in Task 2

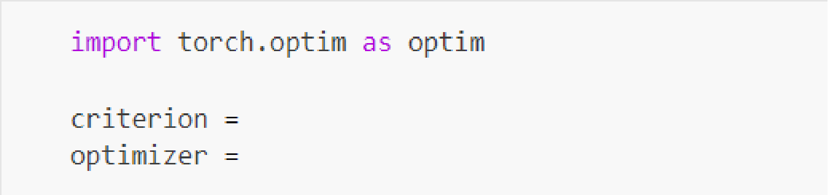
Task2 Code

Hyperparameters



```
EPOCH =
Batch_size =  # 10000 should be divisible by batch_num
Learning_rate =
```

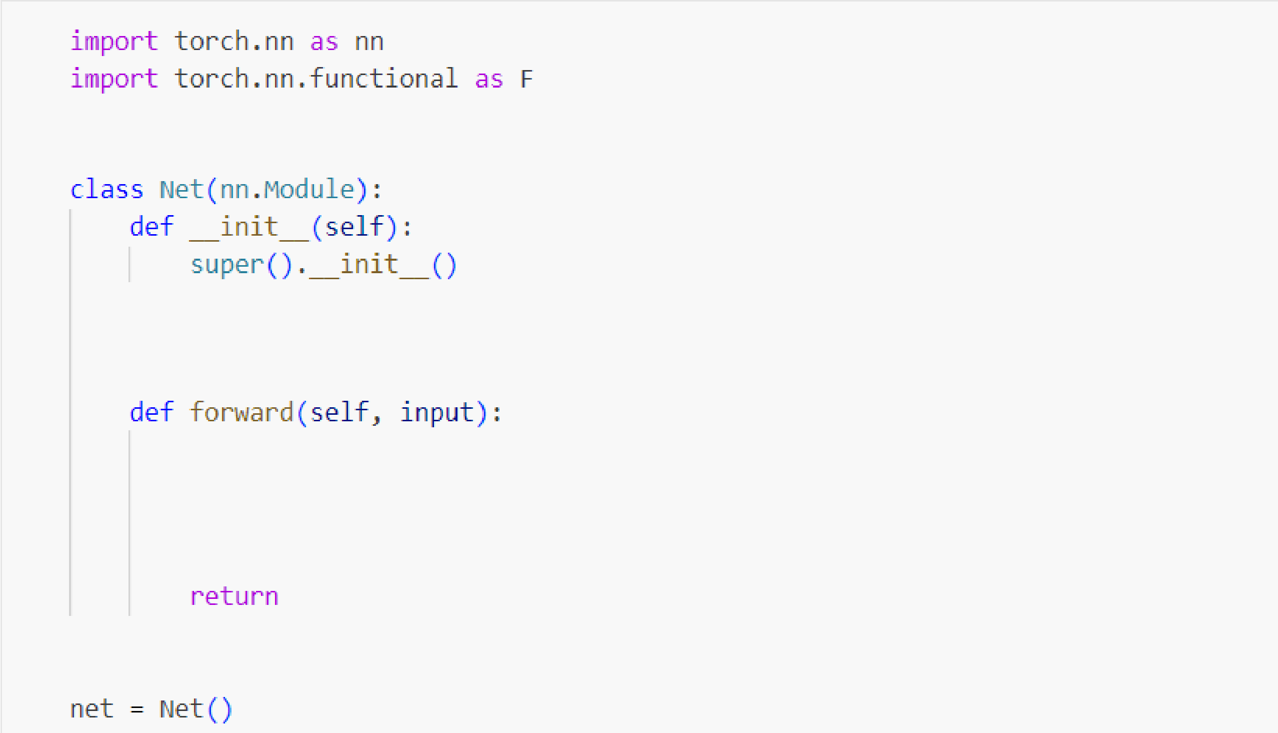
Criterion and Optimizer



```
import torch.optim as optim

criterion =
optimizer =
```

Build the network using pytorch



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


class Net(nn.Module):
    def __init__(self):
        super().__init__()



    def forward(self, input):




        return


net = Net()
```

PyTorch tutorial

- Official tutorial
  - https://pytorch.org/tutorials/
- 莫凡
  - https://mofanpy.com/tutorials/machine-learning/torch/
- AssemblyAI - PyTorch Crash Course
  - https://www.youtube.com/watch?v=OIenNRt2bjg

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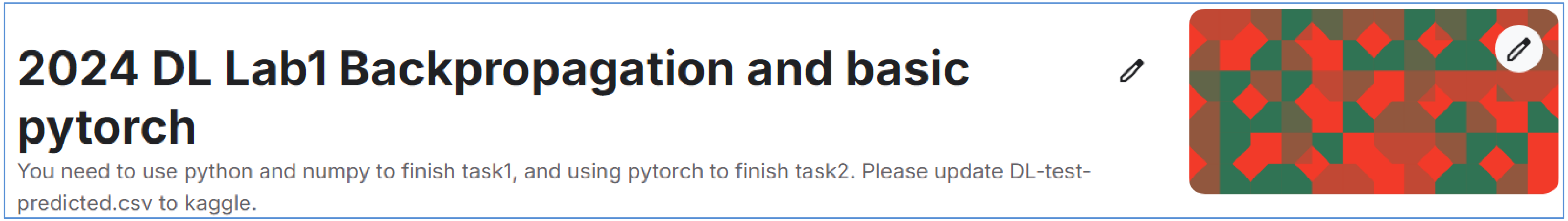
Assignment Regulation

- Please use Google Colab to finish this lab
- Please refer to “Colab_Tutorial_2024.pptx” for further details
- You don’t need to use GPU in this lab

Join Kaggle competition

- Competition URL:
  - https://www.kaggle.com/t/9a54f52550064f998d346bdff61dd47c



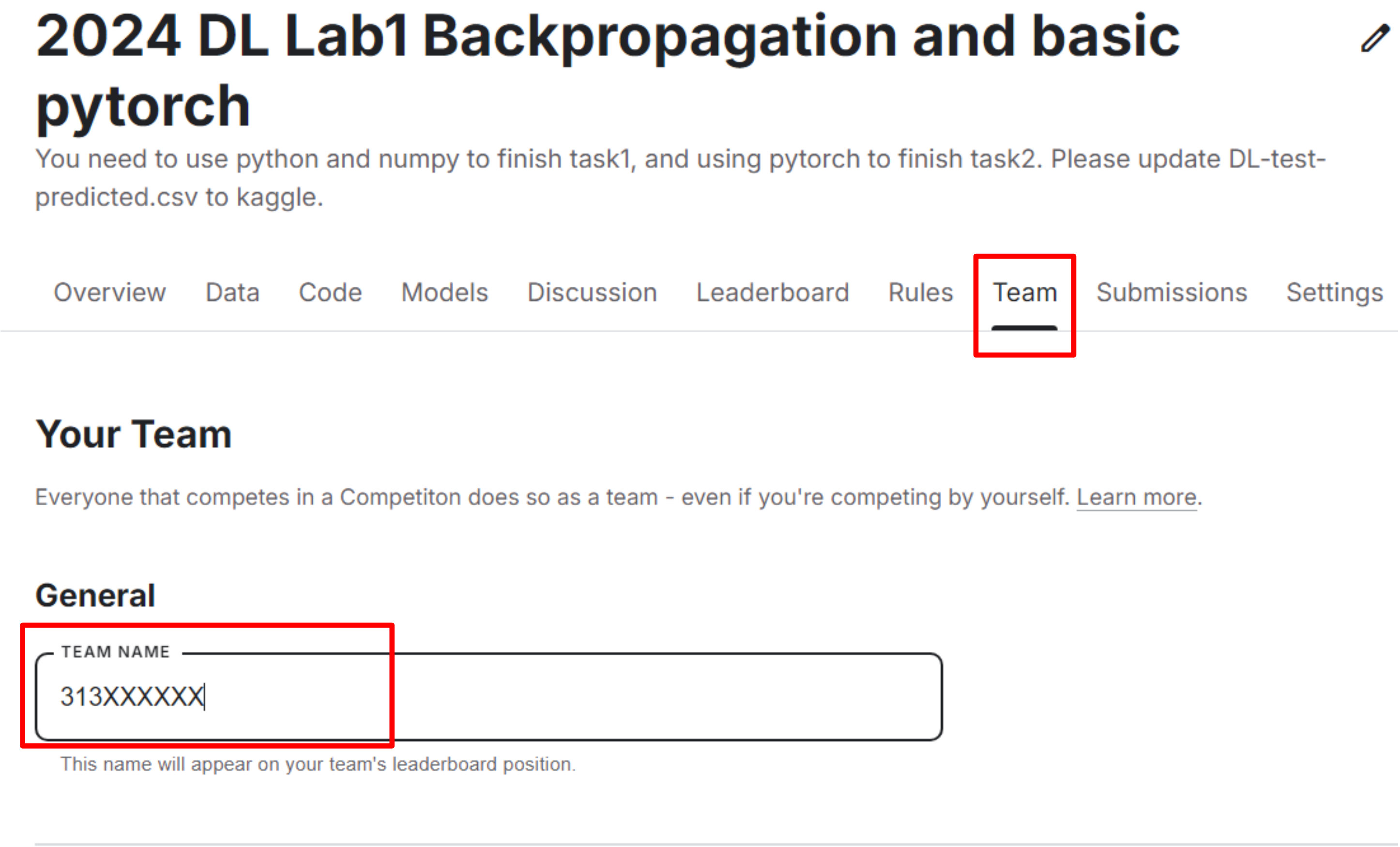
2024 DL Lab1 Backpropagation and basic pytorch

You need to use python and numpy to finish task1, and using pytorch to finish task2. Please update DL-test-predicted.csv to kaggle.

- Upload your test prediction (DL-test-predicted.csv)
- Maximum daily submission limit: 20
- Change your team name to your student ID

Change your team name to your student ID

- If TA can not find your ID, you will loss 30% of score for this lab directly



2024 DL Lab1 Backpropagation and basic pytorch

You need to use python and numpy to finish task1, and using pytorch to finish task2. Please update DL-test-predicted.csv to kaggle.

Your Team

Everyone that competes in a Competiton does so as a team - even if you're competing by yourself. Learn more.

General

TEAM NAME: 313XXXXXX

This name will appear on your team's leaderboard position.

Reminder

- Submit Deadline : 2 weeks (2024/9/23 11:59 PM)
- You need to submit your **code and result** to New E3

- Hand in your code and in the following format (5 files)
  - Lab1_task1_studentid.ipynb
  - network.py
  - layer.py
  - Lab1_task2_studentid.ipynb
  - Lab1_report_studentid.pdf

Grading policy

- Lab1
  - Submit your homework to E3 (60%)
    - Task1 (40%) (validation accuracy should >= 85%, put the screenshot in your report)
    - Task2 (20%) (validation accuracy should >= 85%, put the screenshot in your report)
  - Performance (30%) (submit to Kaggle, test accuracy should >= 82%)
    - The results you upload to Kaggle should be generated only by task1
  - Report (10%)
- Please do not plagiarize (0 points will be calculated if caught)

Report

- How to improve the accuracy (list your method)
  - Your network?
  - Loss function?
  - Activation function?
  - Hyperparameters?
  - Etc…
- What differences do you find between the results of Task1 and Task2?