Machine Learning and Artificial Intelligence

Assignment 4

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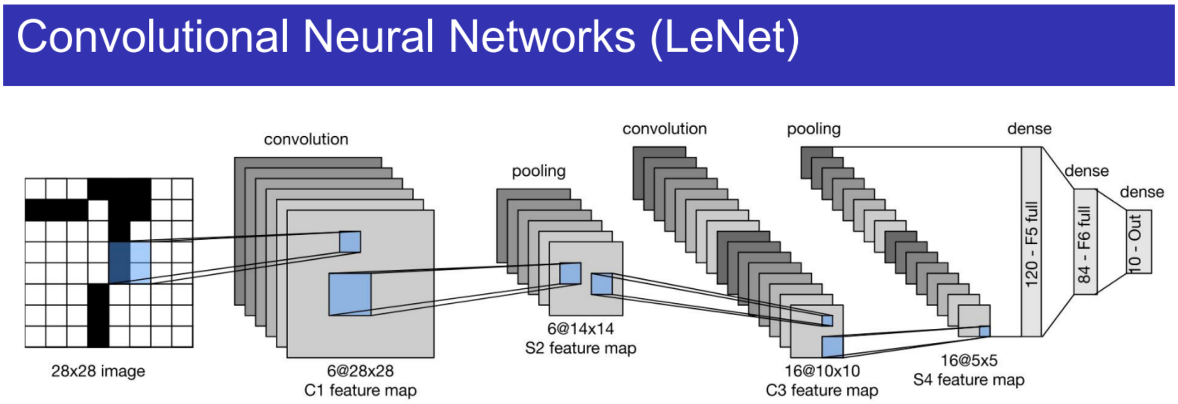
According to the question, we need to construct LeNet-5 to build the model to identify hand-written dataset.

The environment requirements are: pytorch and opencv-python. Using `conda env create -f mlai.yaml` to create the environment in your device.

First, construct the network according to the lecture.




```python
import torch
from torch import nn
from d2l import torch as d2l

net = nn.Sequential(nn.Conv2d(1, 6, kernel_size=5, padding=2), nn.Sigmoid(),
                    nn.AvgPool2d(kernel_size=2, stride=2),
                    nn.Conv2d(6, 16, kernel_size=5), nn.Sigmoid(),
                    nn.AvgPool2d(kernel_size=2, stride=2), nn.Flatten(),
                    nn.Linear(16 * 5 * 5, 120), nn.Sigmoid(),
                    nn.Linear(120, 84), nn.Sigmoid(), nn.Linear(84, 10))
```

jupyter LeNet5.py 上星期四19:16

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```python
import torch

import torch.nn as nn


class LeNet5(nn.Module):
    def __init__(self):
        super().__init__()
        self.net = nn.Sequential(nn.Conv2d(1, 6, kernel_size=5, padding=2), nn.Sigmoid(),
                                 nn.AvgPool2d(kernel_size=2, stride=2),
                                 nn.Conv2d(6, 16, kernel_size=5), nn.Sigmoid(),
                                 nn.AvgPool2d(kernel_size=2, stride=2), nn.Flatten(),
                                 nn.Linear(16 * 5 * 5, 120), nn.Sigmoid(),
                                 nn.Linear(120, 84), nn.Sigmoid(), nn.Linear(84, 10))


    def forward(self, x):
        x = self.net(x)
        return x

```

Then, load MNIST dataset for training. Since we use `from torchvision.datasets import mnist` , it's naturally divided into train and test set. We directly use them. Also, we just transform these images into tensors for training. Other setting:

```
device = 'cuda' if torch.cuda.is_available() else 'cpu'
batch_size = 256
model = LeNet5().to(device)
optimizer = Adam(model.parameters(), lr=1e-3)
loss_fn = CrossEntropyLoss()
all_epoch = 100
```

Then, start training and saving the model states.

```
Epoch 0/100: Loss=1.163798, Accuracy=0.689100
Epoch 1/100: Loss=0.612977, Accuracy=0.838400
Epoch 2/100: Loss=0.443324, Accuracy=0.886400
Epoch 3/100: Loss=0.351810, Accuracy=0.908300
Epoch 4/100: Loss=0.301460, Accuracy=0.922400
Epoch 5/100: Loss=0.267620, Accuracy=0.932200
Epoch 6/100: Loss=0.242694, Accuracy=0.939700
Epoch 7/100: Loss=0.223391, Accuracy=0.946700
...
Epoch 91/100: Loss=0.014673, Accuracy=0.986600
Epoch 92/100: Loss=0.006980, Accuracy=0.987500
Epoch 93/100: Loss=0.002542, Accuracy=0.985600
Epoch 94/100: Loss=0.001653, Accuracy=0.983200
Epoch 95/100: Loss=0.002920, Accuracy=0.980000
Epoch 96/100: Loss=0.001504, Accuracy=0.985900
Epoch 97/100: Loss=0.001837, Accuracy=0.985600
Epoch 98/100: Loss=0.001890, Accuracy=0.986800
Epoch 99/100: Loss=0.011064, Accuracy=0.987200
Model finished training
```

Finally, using hand-written images for prediction.

Since the background noise is too large to predict when taking photos of hand-written images, we scan the hand-written numbers into pdf file and divide them by hand (in the path './test_imgs/raw'). Besides, using `cv2` to resize the image into 28*28 as MNIST dataset.

When predicting, we need to turn white background into black as MNIST dataset. Prediction results are:

Predict*2\Raw	0	1	2	3	4	5	6	7	8	9
number_0.png	9	1	2	3	4	5	6	7	8	7
number_1.png	0	1	2	3	4	5	6	7	8	9

The results show that errors occur for number 0 and number 9, which may due to their similar structures. Accuracy is 90%.

Details show in python and jupyter notebook files.