[PyTorch 学习笔记] 8.4 手动实现 RNN

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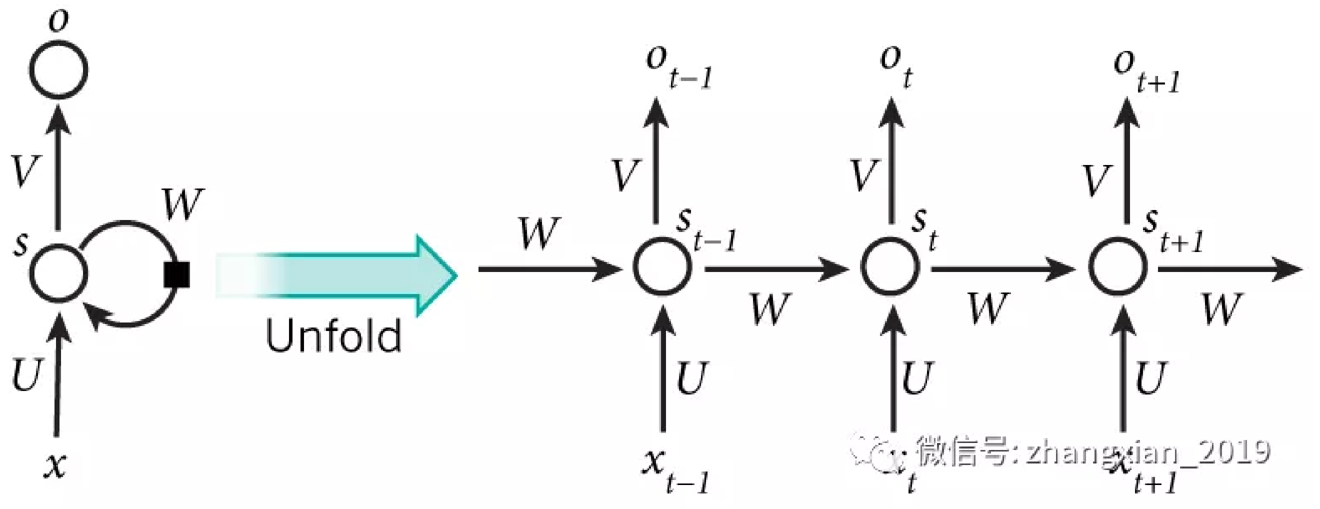
收录于话题
#PyTorch 26个

> 本章代码：https://github.com/zhangxiann/PyTorch_Practice/blob/master/lesson8/rnn_demo.py

这篇文章主要介绍了循环神经网络（Recurrent Neural Network），简称 RNN。

RNN 常用于处理不定长输入，常用于 NLP 以及时间序列的任务，这种数据一般具有前后关系。

RNN 网络结构如下：



上图的数据说明如下：

- x_t：时刻 t 的输入，$shape=(1,57)$，表示 `(batch_size, feature_dim)` 。57 表示词向量的长度。
- s_t：时刻 t 的状态值，$shape=(1，\quad 128)$，表示 `(batch_size, hidden_dim)` 。这个状态值有两个作用：经过一个全连接层得到输出；输入到下一个时刻，影响下一个时刻的状态值。也称为 `hedden_state` ，隐藏层状态信息，记录过往时刻的信息。第一个时刻的 s_t 会初始化为全 0 的向量。
- o_t：时刻 t 的输出，$shape=(1,18)$，表示 `(batch_size, classes)` 。

- U：linear 层输入 x_t 的权重参数，$shape=(57,128)$，表示 `(feature_dim, hidden_dim)`
- W：linear 层状态值 s_{t-1} 的权重参数，$shape=(128,128)$，表示 `(hidden_dim, hidden_dim)` 。
- V：linear 层状态值 s_t 的权重参数，$shape=(128,18)$，表示 `(hidden_dim, classes)` 。

公式如下：

$$s_t=f(x_tU+s_{t-1}W)$$

$$o_t=\text{softmax}(s_tV)$$

下面的例子是使用 RNN 实现人人名分类：输入任意长度姓名（字符串），输出姓名来自哪个国家（18 分类任务）。数据来源于：http://download.pytorch.org/tutorial/data.zip

```
# Chou(字符串) -> RNN -> Chinese(分类类别)
for string in [C,h,o,u]:
 首先把每个字母转换成 one-hot -> [0,0,...,1,...,0]
 y,h=model([0,0,...,1,...,0], h) # h 就是隐藏层的状态信息
```

这里没有使用 DataLoader 和 Dataset，而是手动构造了数据集的结构，训练数据使用 dict 存储，包括 18 个元素，每个元素是一个 list，存储了 18 个类别的名字列表。label 存放在一个 list 中。在迭代训练过程如下：

- 首先随机选择 label 和名字，名字转换为 one-hot 的张量，形状为 $[length,1,57]$，其中 `length` 表示名字的长度，label 也转换为张量，形状为 1。
- 初始化隐藏层状态信息。
- 循环把名字中的每个字符的 one-hot 向量输入到 RNN 中。
- 最后得到 18 分类的 output。
- 这里没有使用优化器，而是手动进行反向传播更新参数值。

代码如下：

```
from io import open
import glob
import unicodedata
import string
import math
import os
```

```python
import time
import torch.nn as nn
import torch
import random
import matplotlib.pyplot as plt
import torch.utils.data
from common_tools import set_seed
import enviroments


set_seed(1)  # 设置随机种子
BASE_DIR = os.path.dirname(os.path.abspath(__file__))
# device = torch.device("cuda" if torch.cuda.is_available() else "cpu")
device = torch.device("cpu")



# Read a file and split into lines
def readLines(filename):
    lines = open(filename, encoding='utf-8').read().strip().split('\n')
    return [unicodeToAscii(line) for line in lines]



def unicodeToAscii(s):
    return ''.join(
        c for c in unicodedata.normalize('NFD', s)
        if unicodedata.category(c) != 'Mn'
        and c in all_letters)



# Find letter index from all_letters, e.g. "a" = 0
def letterToIndex(letter):
    return all_letters.find(letter)



# Just for demonstration, turn a letter into a <1 x n_letters> Tensor
def letterToTensor(letter):
    tensor = torch.zeros(1, n_letters)
    tensor[0][letterToIndex(letter)] = 1
    return tensor



# Turn a line into a <line_length x 1 x n_letters>,
# or an array of one-hot letter vectors
def lineToTensor(line):
    tensor = torch.zeros(len(line), 1, n_letters)
    for li, letter in enumerate(line):
        tensor[li][0][letterToIndex(letter)] = 1
    return tensor
```

```python
def categoryFromOutput(output):
    top_n, top_i = output.topk(1)
    category_i = top_i[0].item()
    return all_categories[category_i], category_i


def randomChoice(l):
    return l[random.randint(0, len(l) - 1)]


def randomTrainingExample():
    category = randomChoice(all_categories)                 # 选类别
    line = randomChoice(category_lines[category])           # 选一个样本
    category_tensor = torch.tensor([all_categories.index(category)], dtype=torch.long)
    line_tensor = lineToTensor(line)    # str to one-hot
    return category, line, category_tensor, line_tensor


def timeSince(since):
    now = time.time()
    s = now - since
    m = math.floor(s / 60)
    s -= m * 60
    return '%dm %ds' % (m, s)


# Just return an output given a line
def evaluate(line_tensor):
    hidden = rnn.initHidden()

    for i in range(line_tensor.size()[0]):
        output, hidden = rnn(line_tensor[i], hidden)

    return output


def predict(input_line, n_predictions=3):
    print('\n> %s' % input_line)
    with torch.no_grad():
        output = evaluate(lineToTensor(input_line))

        # Get top N categories
        topv, topi = output.topk(n_predictions, 1, True)

        for i in range(n_predictions):
            value = topv[0][i].item()
            category_index = topi[0][i].item()
            print('(%.2f) %s' % (value, all_categories[category_index]))
```

```
def get_lr(iter, learning_rate):
    lr_iter = learning_rate if iter < n_iters else learning_rate*0.1
    return lr_iter

class RNN(nn.Module):
    def __init__(self, input_size, hidden_size, output_size):
        super(RNN, self).__init__()

        self.hidden_size = hidden_size

        self.u = nn.Linear(input_size, hidden_size)
        self.w = nn.Linear(hidden_size, hidden_size)
        self.v = nn.Linear(hidden_size, output_size)

        self.tanh = nn.Tanh()
        self.softmax = nn.LogSoftmax(dim=1)

    def forward(self, inputs, hidden):

        u_x = self.u(inputs)

        hidden = self.w(hidden)
        hidden = self.tanh(hidden + u_x)

        output = self.softmax(self.v(hidden))

        return output, hidden

    def initHidden(self):
        return torch.zeros(1, self.hidden_size)


def train(category_tensor, line_tensor):
    hidden = rnn.initHidden()

    rnn.zero_grad()

    line_tensor = line_tensor.to(device)
    hidden = hidden.to(device)
    category_tensor = category_tensor.to(device)

    for i in range(line_tensor.size()[0]):
        output, hidden = rnn(line_tensor[i], hidden)

    loss = criterion(output, category_tensor)
    loss.backward()

    # Add parameters' gradients to their values, multiplied by learning rate
    for p in rnn.parameters():
        p.data.add_(-learning_rate, p.grad.data)
```

```python
        return output, loss.item()


if __name__ == "__main__":
    # config
    path_txt = os.path.join(enviroments.names,"*.txt")
    all_letters = string.ascii_letters + " .,;'"
    n_letters = len(all_letters)    # 52 + 5 字符总数
    print_every = 5000
    plot_every = 5000
    learning_rate = 0.005
    n_iters = 200000

    # step 1 data
    # Build the category_lines dictionary, a list of names per language
    category_lines = {}
    all_categories = []
    for filename in glob.glob(path_txt):
        category = os.path.splitext(os.path.basename(filename))[0]
        all_categories.append(category)
        lines = readLines(filename)
        category_lines[category] = lines

    n_categories = len(all_categories)

    # step 2 model
    n_hidden = 128
    # rnn = RNN(n_letters, n_hidden, n_categories)
    rnn = RNN(n_letters, n_hidden, n_categories)

    rnn.to(device)

    # step 3 loss
    criterion = nn.NLLLoss()

    # step 4 optimize by hand

    # step 5 iteration
    current_loss = 0
    all_losses = []
    start = time.time()
    for iter in range(1, n_iters + 1):
        # sample
        category, line, category_tensor, line_tensor = randomTrainingExample()

        # training
        output, loss = train(category_tensor, line_tensor)
        current_loss += loss

        # Print iter number, loss, name and guess
        if iter % print_every == 0:
            guess, guess_i = categoryFromOutput(output)
            correct = '✓' if guess == category else '✗ (%s)' % category
            print('Iter: {:<7} time: {:>8s} loss: {:.4f} name: {:>10s}  pred: {:>8s} label: {:>8s}
                iter, timeSince(start), loss, line, guess, correct))

        # Add current loss avg to list of losses
        if iter % plot_every == 0:
            all_losses.append(current_loss / plot_every)
            current_loss = 0
path_model = os.path.join(BASE_DIR, "rnn_state_dict.pkl")
torch.save(rnn.state_dict(), path_model)
plt.plot(all_losses)
plt.show()

predict('Yue Tingsong')
predict('Yue tingsong')
predict('yutingsong')

predict('test your name')
```

参考资料

- 深度之眼 PyTorch 框架班

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