RMSProp

```
def rmsprop(parameters, sqrs, lr, alpha):
    eps = 1e-10
    for param, sqr in zip(parameters, sqrs):
        sqr[:] = alpha * sqr + (1 - alpha) * param.grad.data ** 2
        div = lr / torch.sqrt(sqr + eps) * param.grad.data
        param.data = param.data - div
```

```
import numpy as np
import torch
from torchvision.datasets import MNIST # 导入 pytorch 内置的 mnist 数据
from torch.utils.data import DataLoader
from torch import nn
from torch.autograd import Variable
import time
import matplotlib.pyplot as plt
%matplotlib inline

def data_tf(x):
    x = np.array(x, dtype='float32') / 255
    x = (x - 0.5) / 0.5 # 标准化，这个技巧之后会讲到
    x = x.reshape((-1,)) # 拉平
    x = torch.from_numpy(x)
    return x

train_set = MNIST('./data', train=True, transform=data_tf, download=True) # 载入数据
集，申明定义的数据变换
test_set = MNIST('./data', train=False, transform=data_tf, download=True)

# 定义 loss 函数
criterion = nn.CrossEntropyLoss()
```

```
train_data = DataLoader(train_set, batch_size=64, shuffle=True)
# 使用 Sequential 定义 3 层神经网络
net = nn.Sequential(
    nn.Linear(784, 200),
    nn.ReLU(),
    nn.Linear(200, 10),
)
```

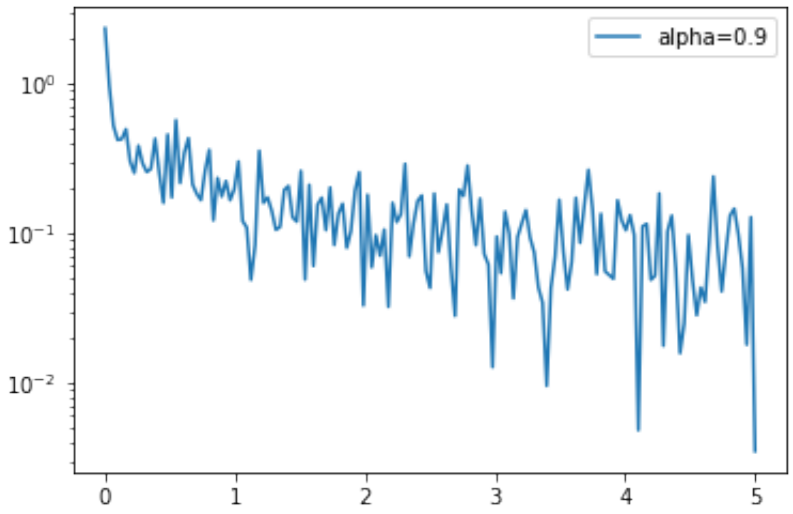
```
# 初始化梯度平方项
sqrs = []
for param in net.parameters():
    sqrs.append(torch.zeros_like(param.data))

# 开始训练
losses = []
idx = 0
start = time.time() # 记时开始
for e in range(5):
    train_loss = 0
    for im, label in train_data:
        im = Variable(im)
        label = Variable(label)
        # 前向传播
        out = net(im)
        loss = criterion(out, label)
        # 反向传播
        net.zero_grad()
        loss.backward()
        rmsprop(net.parameters(), sqrs, 1e-3, 0.9) # 学习率设为 0.001, alpha 设为 0.9
        # 记录误差
        train_loss += loss.data[0]
        if idx % 30 == 0:
            losses.append(loss.data[0])
        idx += 1
    print('epoch: {}, Train Loss: {:.6f}'
          .format(e, train_loss / len(train_data)))
end = time.time() # 计时结束
print('使用时间: {:.5f} s'.format(end - start))
```

```
epoch: 0, Train Loss: 0.363507
epoch: 1, Train Loss: 0.161640
epoch: 2, Train Loss: 0.120954
epoch: 3, Train Loss: 0.101136
epoch: 4, Train Loss: 0.085934
使用时间: 58.86966 s
```

```
x_axis = np.linspace(0, 5, len(losses), endpoint=True)
plt.semilogy(x_axis, losses, label='alpha=0.9')
plt.legend(loc='best')
```

```
<matplotlib.legend.Legend at 0x106998470>
```

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losses = []
idx = 0

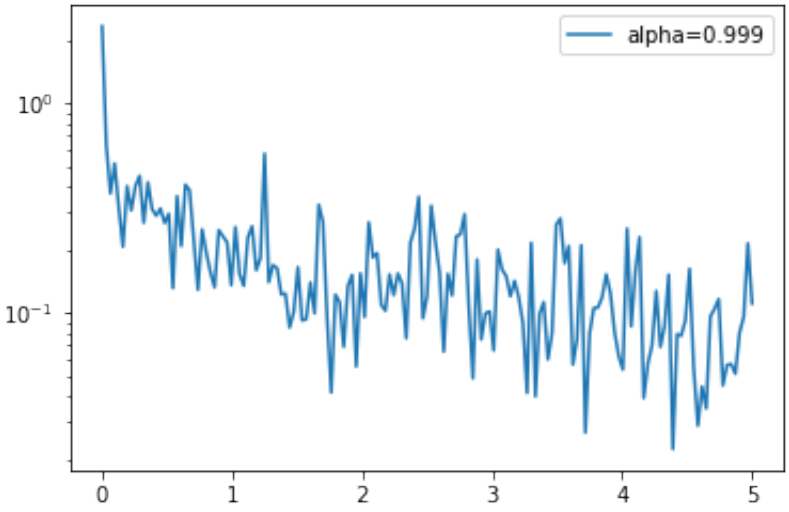
start = time.time() # 记时开始
for e in range(5):
    train_loss = 0
    for im, label in train_data:
        im = Variable(im)
        label = Variable(label)
```

```
        # 前向传播
        out = net(im)
        loss = criterion(out, label)
        # 反向传播
        net.zero_grad()
        loss.backward()
        rmsprop(net.parameters(), sqrs, 1e-3, 0.999) # 学习率设为 0.001，alpha 设为
0.999
        # 记录误差
        train_loss += loss.data[0]
        if idx % 30 == 0:
            losses.append(loss.data[0])
        idx += 1
    print('epoch: {}, Train Loss: {:.6f}'
          .format(e, train_loss / len(train_data)))
end = time.time() # 计时结束
print('使用时间: {:.5f} s'.format(end - start))
```

```
epoch: 0, Train Loss: 0.471134
epoch: 1, Train Loss: 0.188616
epoch: 2, Train Loss: 0.148085
epoch: 3, Train Loss: 0.124590
epoch: 4, Train Loss: 0.107619
使用时间: 70.13240 s
```

```
x_axis = np.linspace(0, 5, len(losses), endpoint=True)
plt.semilogy(x_axis, losses, label='alpha=0.999')
plt.legend(loc='best')
```

```
<matplotlib.legend.Legend at 0x10c160d68>
```



小练习：可以看到使用了不同的 alpha 会使得 loss 在下降过程中的震荡程度不同，想想为什么

当然 pytorch 也内置了 rmsprop 的方法，非常简单，只需要调用 `torch.optim.RMSprop()` 就可以了，下面是例子

```
train_data = DataLoader(train_set, batch_size=64, shuffle=True)
# 使用 Sequential 定义 3 层神经网络
net = nn.Sequential(
    nn.Linear(784, 200),
    nn.ReLU(),
    nn.Linear(200, 10),
)

optimizer = torch.optim.RMSprop(net.parameters(), lr=1e-3, alpha=0.9)

# 开始训练

start = time.time() # 记时开始
for e in range(5):
    train_loss = 0
    for im, label in train_data:
        im = Variable(im)
        label = Variable(label)
        # 前向传播
        out = net(im)
        loss = criterion(out, label)
        # 反向传播
        optimizer.zero_grad()
        loss.backward()
        optimizer.step()
        # 记录误差
        train_loss += loss.data[0]
```

```
    print('epoch: {}, Train Loss: {:.6f}'
          .format(e, train_loss / len(train_data)))
end = time.time() # 计时结束
print('使用时间: {:.5f} s'.format(end - start))
```

```
epoch: 0, Train Loss: 0.372473
epoch: 1, Train Loss: 0.164288
epoch: 2, Train Loss: 0.122384
epoch: 3, Train Loss: 0.100739
epoch: 4, Train Loss: 0.088391
使用时间: 85.15531 s
```