BPNetworks

2022 年 4 月 23 日

[ ]:
```
import numpy as np
import matplotlib.pyplot as plt
from scipy.special import expit
import struct,os
from array import array as pyarray
from numpy import append, array, int8, uint8, zeros

def load_mnist(image_file, label_file):
    digits=np.arange(10)

    fname_image = os.path.join(image_file)
    fname_label = os.path.join(label_file)

    flbl = open(fname_label, 'rb')
    magic_nr, size = struct.unpack(">II", flbl.read(8))
    lbl = pyarray("b", flbl.read())
    flbl.close()

    fimg = open(fname_image, 'rb')
    magic_nr, size, rows, cols = struct.unpack(">IIII", fimg.read(16))
    img = pyarray("B", fimg.read())
    fimg.close()

    ind = [ k for k in range(size) if lbl[k] in digits ]
    N = len(ind)

    images = zeros((N, rows*cols), dtype=uint8)
    labels = zeros((N, 1), dtype=int8)
```

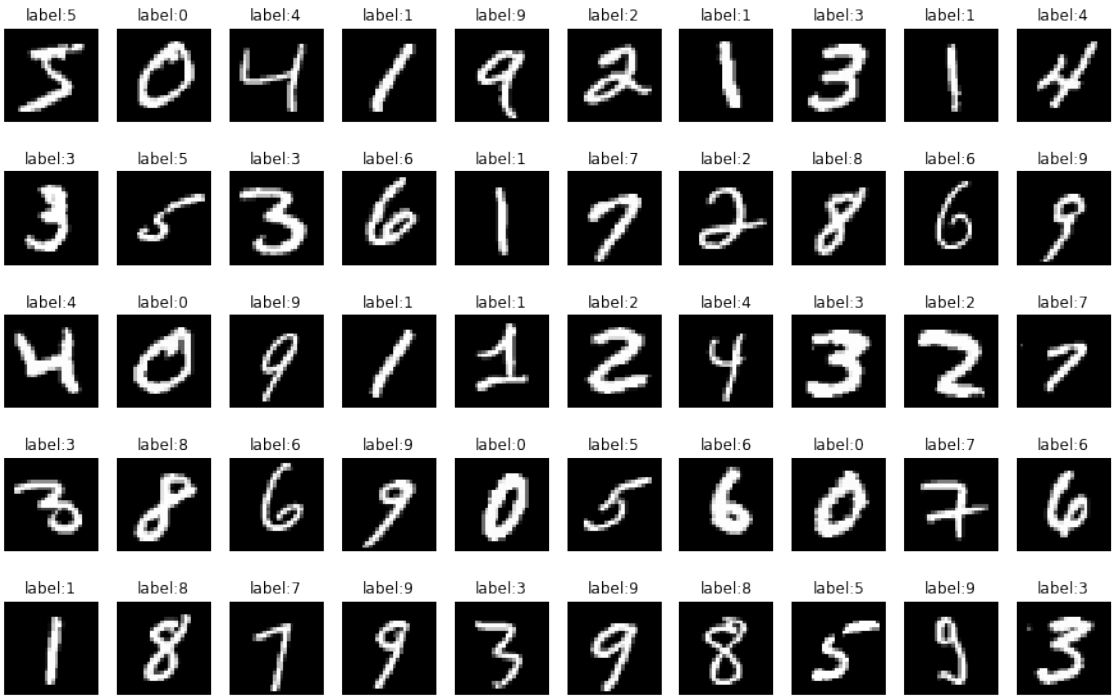
```
    for i in range(len(ind)):
        images[i] = array(img[ ind[i]*rows*cols : (ind[i]+1)*rows*cols ]).
 ↪reshape((1, rows*cols))
        labels[i] = lbl[ind[i]]

    return images, labels


train_image, train_label = load_mnist("train-images.idx3-ubyte", "train-labels.
 ↪idx1-ubyte")
test_image, test_label = load_mnist("t10k-images.idx3-ubyte", "t10k-labels.
 ↪idx1-ubyte")
train_image=train_image[:5000]
train_label=train_label[:5000]
```

[ ]:
```
import matplotlib.pyplot as plt

def show_image(imgdata,imgtarget,show_column):
    show_row=len(imgdata)//show_column
    for index,(im,it) in enumerate(list(zip(imgdata,imgtarget))):
        xx = im.reshape(28,28)
        plt.subplots_adjust(left=1, bottom=None, right=3, top=2, wspace=None,␣
 ↪hspace=None)
        plt.subplot(show_row, show_column, index+1)
        plt.axis('off')
        plt.imshow(xx , cmap='gray',interpolation='nearest')
        plt.title('label:%i' % it)
show_image(train_image[:50], train_label[:50], 10)
```



[ ]:
```
hidden_size=20*20
gama=np.random.rand(hidden_size)-0.5
#print(gama.shape)
out_size=10
theta=np.random.rand(out_size)-0.5
v=np.random.rand(train_image.shape[1],hidden_size)-0.5
#print("v's shape",v.shape)
w=np.random.rand(hidden_size,out_size)-0.5

ty=np.zeros([train_image.shape[0],out_size])
for i in range(train_image.shape[0]):
    ty[i][train_label[i]]=1.0
print(theta.shape)
```

```
(10,)
```

[ ]:
```
def predict(img):
    return expit(expit(img.dot(v)-gama).dot(w)-theta)
```

[ ]:
```
def print_genaralization_error():
    err=0
    for i in range(test_image.shape[0]):
        Y=predict(test_image[i])
        ans=0
        mx=Y[0]
        for j in range(len(Y)):
            if Y[j]>mx:
                mx=Y[j]
                ans=j
        if test_label[i]!=ans:
            # plt.gray()
            # plt.matshow(test_image[i].reshape(28,-1))
            # plt.show()
            # print("%d pred %d truth %d"% (i,ans,test_label[i]))
            err+=1
    print("%.10lf"%(1-err/test_image.shape[0]))
print_genaralization_error()
```

```
0.8633000000
```

[ ]:
```
def print_train_error():
    err=0
    for i in range(train_image.shape[0]):
        Y=predict(train_image[i])
        ans=0
        mx=Y[0]
        for j in range(len(Y)):
            if Y[j]>mx:
                mx=Y[j]
                ans=j
        if train_label[i]!=ans:
            # plt.gray()
            # plt.matshow(test_image[i].reshape(28,-1))
            # plt.show()
            # print("%d pred %d truth %d"% (i,ans,test_label[i]))
            err+=1
```

```
    print("%.10lf"%(1-err/train_image.shape[0]))
print_train_error()
```

```
0.9710000000
```

[ ]:
```
alpha=0.00005
T=20000
while T>0:
    b=expit(train_image.dot(v)-gama)
    y=expit(b.dot(w)-theta)
    g=y*(1-y)*(ty-y)
    e=b*(1-b)*(g.dot(w.T)) # (w*(g^T))^T=g*(w^T)
    w+=alpha*(b.T).dot(g)
    v+=alpha*(train_image.T).dot(e)
    theta-=alpha*(g.sum(axis=0))
    gama-=alpha*(e.sum(axis=0))
    # print(theta)
    T-=1
    if(T%1000==0):
        print(T)
        print_train_error()
```

```
19000
0.8838000000
18000
0.8836000000
17000
0.8842000000
16000
0.8848000000
15000
0.8850000000
14000
0.8852000000
13000
0.8860000000
```

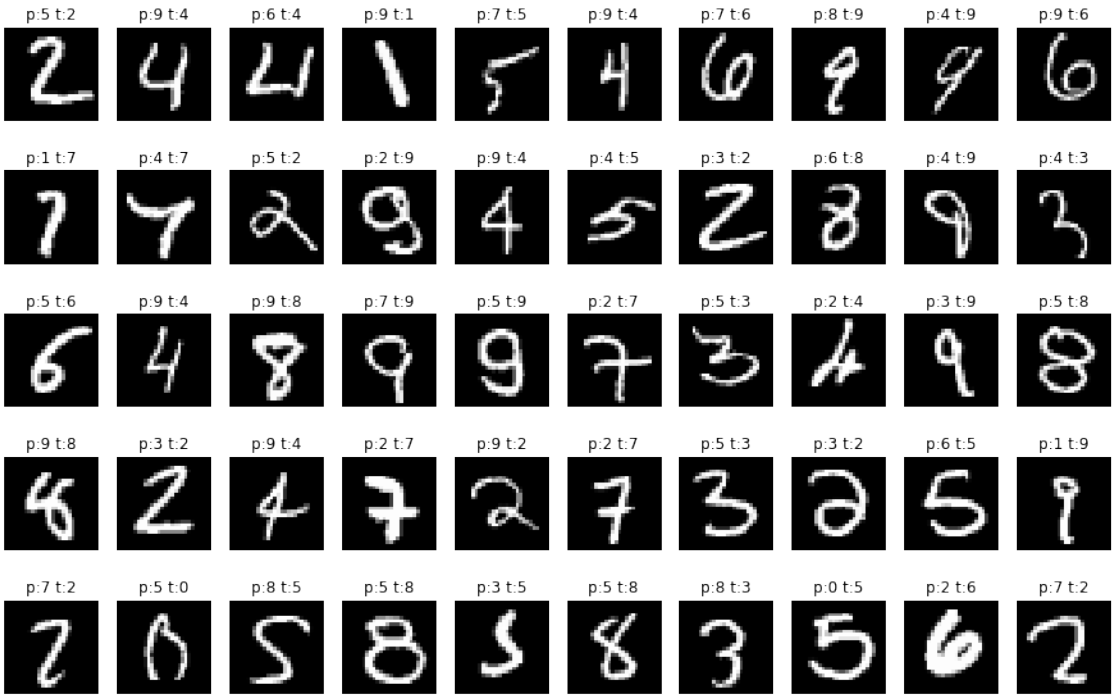
```
12000
0.8866000000
11000
0.9516000000
10000
0.9612000000
9000
0.9644000000
8000
0.9662000000
7000
0.9666000000
6000
0.9680000000
5000
0.9682000000
4000
0.9684000000
3000
0.9692000000
2000
0.9698000000
1000
0.9706000000
0
0.9710000000
```

[ ]:
```
np.savez("trained.npz",v_theta=theta,v_gamma=gama,m_w=w,m_v=v)
```

[ ]:
```
plt.gray()
plt.matshow(test_image[0].reshape(28,-1))
plt.show()
```

[ ]:
```
err=0
for i in range(test_image.shape[0]):
    Y=predict(test_image[i])
    ans=0
```

```
    mx=Y[0]
    for j in range(len(Y)):
        if Y[j]>mx:
            mx=Y[j]
            ans=j
    if test_label[i]!=ans:
        err+=1
        if err<=50:
            plt.subplots_adjust(left=1, bottom=None, right=3, top=2,␣
 ↪wspace=None, hspace=None)
            plt.subplot(5, 10, err)
            plt.axis('off')
            plt.imshow(test_image[i].reshape(28,-1) ,␣
 ↪cmap='gray',interpolation='nearest')
            plt.title("p:%d t:%d"% (ans,test_label[i]))
plt.show()
print(str(err)+"/"+str(test_image.shape[0]))
```



1367/10000

[ ]:
```
v.shape
```

[ ]:
```
(784, 400)
```

[ ]:
```
hidden=v.T[:50]
for index,im in enumerate(list(hidden)):
        xx = im.reshape(28,28)
        plt.subplots_adjust(left=1, bottom=None, right=3, top=2, wspace=None,␣
 ↪hspace=None)
        plt.subplot(5, 10, index+1)
        plt.axis('off')
        plt.imshow(xx , cmap='gray',interpolation='nearest')
```