

Report

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数据集

使用CloudCompare生成

总共4个类别：立方体，球体，圆柱体，圆锥

200采样点，采样位于表面

训练集：每个类别50个数据

验证集：每个类别10个数据

测试集：每个类别10个数据

数据样式：

```
//X Y Z Nx Ny Nz
203
-0.11928070 -0.10144745 0.50000000 0.000978 0.000978 0.999999
-0.46182662 0.38041669 0.50000000 0.000978 0.000978 0.999999
-0.45229715 -0.27415663 0.50000000 0.000978 0.000978 0.999999
-0.28705189 0.33171543 0.50000000 0.000978 0.000978 0.999999
-0.38907254 0.48512840 0.50000000 0.000978 0.000978 0.999999
-0.38976368 0.30858698 0.50000000 0.000978 0.000978 0.999999
-0.49856043 -0.39558029 0.50000000 0.000978 0.000978 0.999999
-0.45906153 -0.08887327 0.50000000 0.000978 0.000978 0.999999
0.04745513 0.39641124 0.50000000 0.000978 0.000978 0.999999
-0.00171831 0.10927463 0.50000000 0.000978 0.000978 0.999999
-0.31550294 -0.00989217 0.50000000 0.000978 0.000978 0.999999
```

训练只采用前三列，即x,y,z值

项目

由于之前已经读过pointnet论文，所以直接写代码

参考代码：<https://github.com/fxia22/pointnet.pytorch>

实现思路：model.py中定义pointnet网络框架，dataset.py中处理数据集，train.py中训练

参数：

- batchSize 8
- npoint 160
- epoch 10

npoint是每个数据中选取点的数量，由于生成的数据采样点不是严格的200，在170~220左右浮动，所以选取npoint=160；因此每个数据都会剔除些许的点使最后点的数量都为160，剔除方式为随机剔除

```
[epoch9: 20/25] train loss: 0.016304 accuracy: 1.000000
[epoch9: 21/25] train loss: 0.307248 accuracy: 0.875000
[epoch9: 22/25] train loss: 0.896363 accuracy: 0.500000
[epoch9: 23/25] train loss: 0.014751 accuracy: 1.000000
[epoch9: 24/25] train loss: 0.025414 accuracy: 1.000000
[epoch9] varify loss: 0.077109 accuracy: 1.000000
```

最后损失 (nll_loss) : 0.077, 可以发现已经收敛

```
final accuracy: 1.0
```

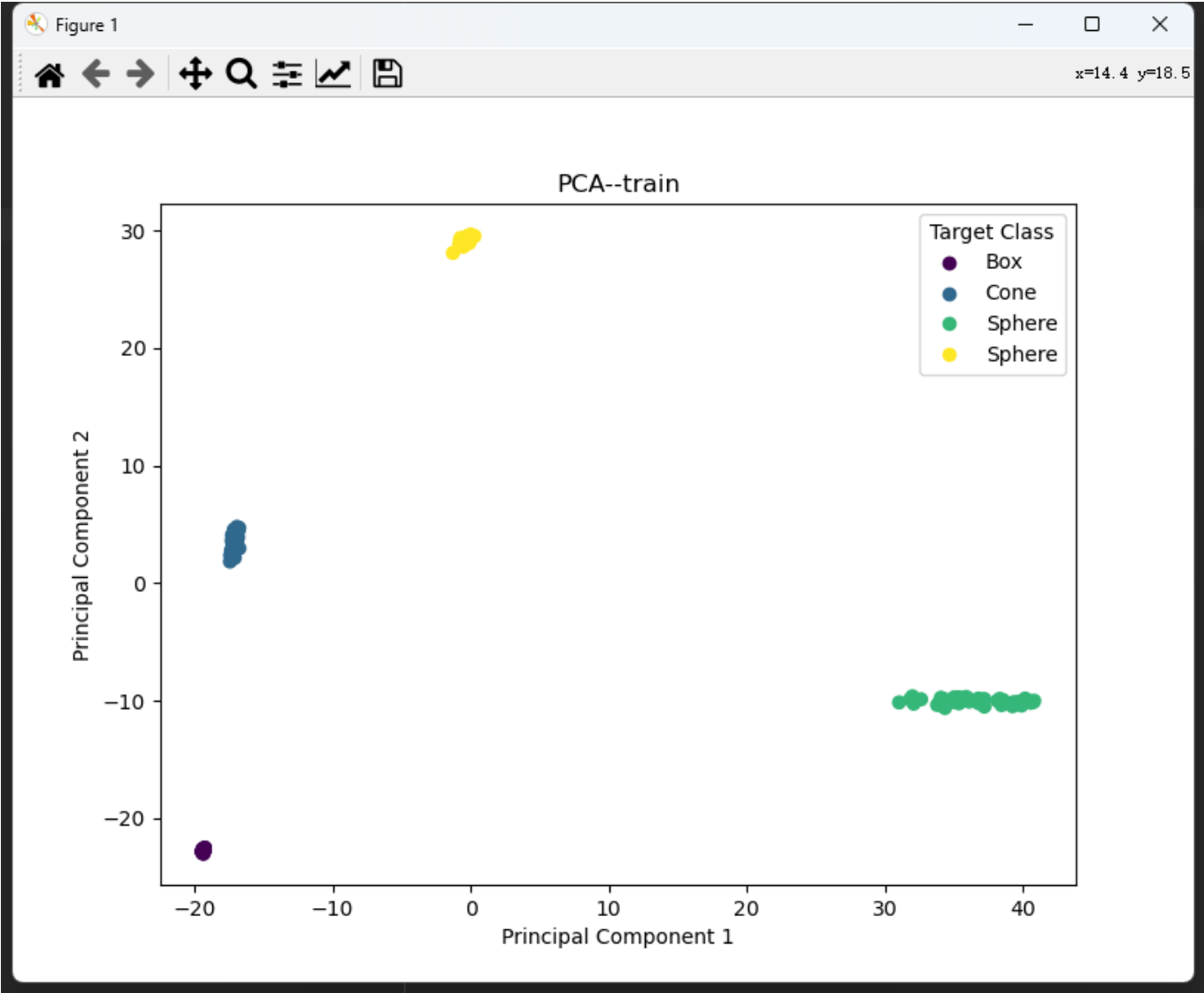
最后准确率: 1.0

实验

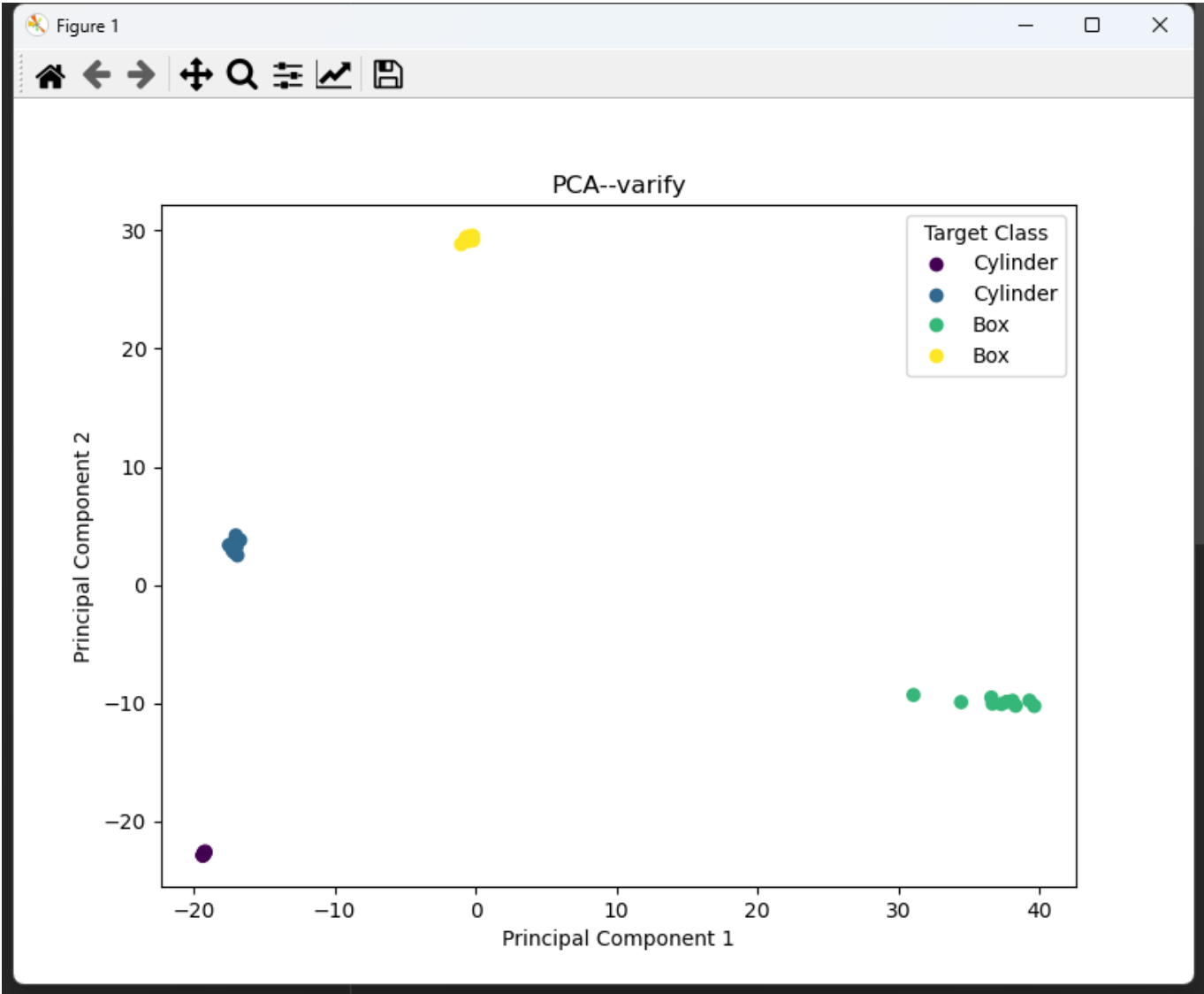
使用PCA将特征降维并可视化，观察4个类别对应的特征 (PCA.py)

使用训练好的模型中的特征提取器，对训练集、验证集、测试集中每个样例提取到1024维的特征，将这个特征使用PCA降至2维，并画出散点图

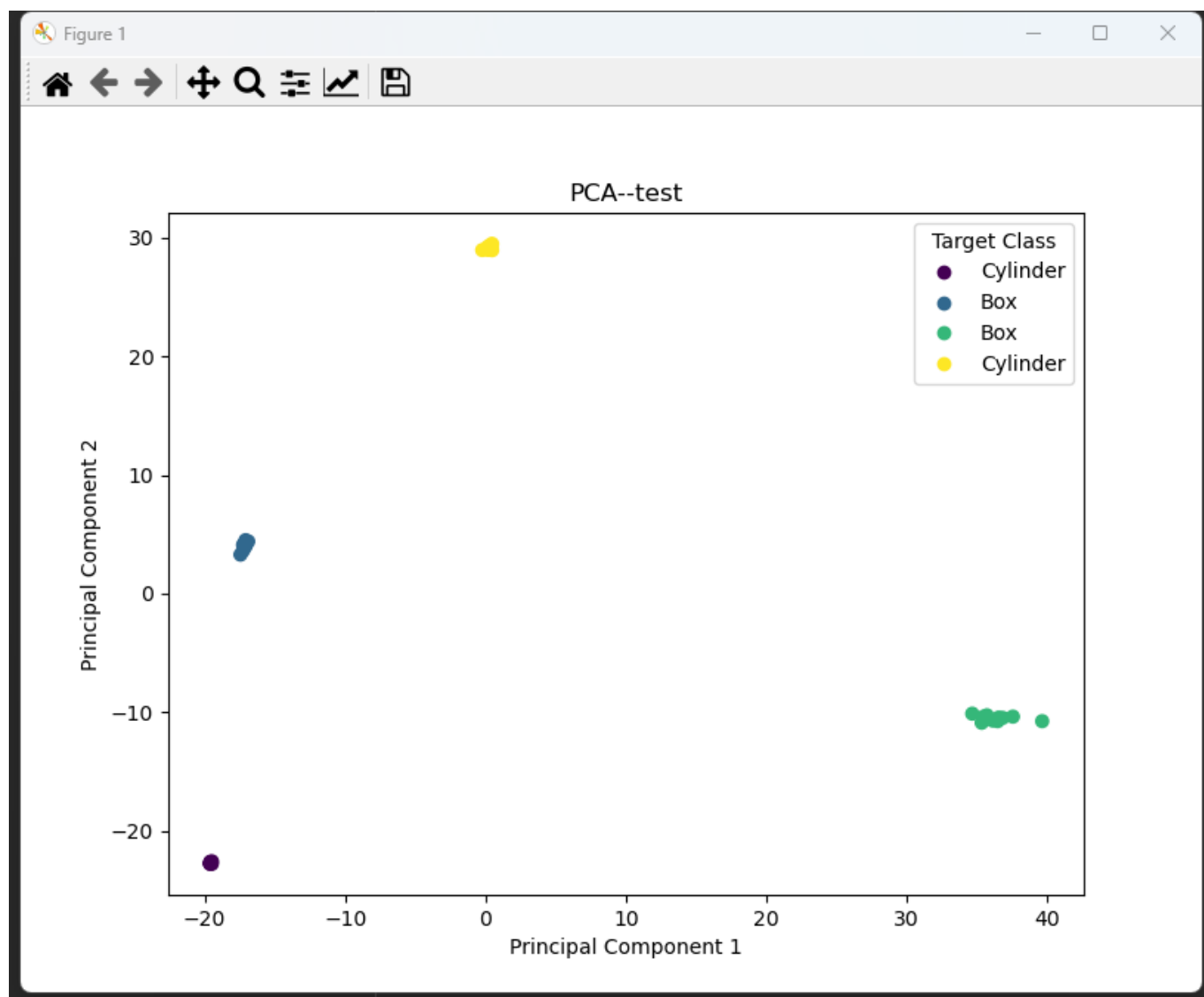
训练集：



验证集：



测试集：



可以发现，降维后4个类别的特征聚在一起，说明每个类别有比较明显的特征，且模型的特征提取是有效的

取消BatchNormalization

```
[epoch9: 20/25] train loss: 0.000000 accuracy: 1.000000
[epoch9: 21/25] train loss: 0.000000 accuracy: 1.000000
[epoch9: 22/25] train loss: 0.000001 accuracy: 1.000000
[epoch9: 23/25] train loss: 0.000001 accuracy: 1.000000
[epoch9: 24/25] train loss: 0.000003 accuracy: 1.000000
[epoch9] varify loss: 0.000000 accuracy: 1.000000
```

准确率不变，loss反而变小了，这个非常有趣

取消学习率调整

```
[epoch9: 20/25] train loss: 0.050794 accuracy: 1.000000
[epoch9: 21/25] train loss: 0.117375 accuracy: 1.000000
[epoch9: 22/25] train loss: 0.154990 accuracy: 0.875000
[epoch9: 23/25] train loss: 0.013822 accuracy: 1.000000
[epoch9: 24/25] train loss: 0.221425 accuracy: 1.000000
[epoch9] varify loss: 0.095216 accuracy: 1.000000
5it [00:00, 114.40it/s]
final accuracy: 1.0
```

虽然准确率无变化，但是loss变高了，说明学习率调整可以优化模型

将Adam算法改为SGD

```
[epoch9: 20/25] train loss: 0.177608 accuracy: 1.000000
[epoch9: 21/25] train loss: 0.361181 accuracy: 1.000000
[epoch9: 22/25] train loss: 0.140429 accuracy: 1.000000
[epoch9: 23/25] train loss: 0.323371 accuracy: 1.000000
[epoch9: 24/25] train loss: 0.281583 accuracy: 1.000000
[epoch9] varify loss: 0.230310 accuracy: 1.000000
5it [00:00, 115.07it/s]
final accuracy: 1.0
```

可以明显感知学习速率提高（读条变快了很多），但loss变高很多
说明Adam算法性能要好一些，但是训练速度会慢一些

取消学习率调整，并修改learning rate

SGD

- $lr = 0.3$, loss大幅提高，准确率降为0.75

```
[epoch9: 20/25] train loss: 0.567308 accuracy: 0.625000
[epoch9: 21/25] train loss: 2.655975 accuracy: 0.500000
[epoch9: 22/25] train loss: 1.616821 accuracy: 0.250000
[epoch9: 23/25] train loss: 0.196529 accuracy: 1.000000
[epoch9: 24/25] train loss: 0.952130 accuracy: 0.375000
[epoch9] varify loss: 0.319971 accuracy: 0.750000
5it [00:00, 102.18it/s]
final accuracy: 0.75
```

- $lr = 0.5$, loss大幅提高，准确率降为0.5

```
[epoch9: 20/25] train loss: 0.721052 accuracy: 0.500000
[epoch9: 21/25] train loss: 0.439305 accuracy: 0.750000
[epoch9: 22/25] train loss: 0.401037 accuracy: 0.750000
[epoch9: 23/25] train loss: 0.620183 accuracy: 0.750000
[epoch9: 24/25] train loss: 0.636219 accuracy: 0.625000
[epoch9] varify loss: 1.005848 accuracy: 0.375000
5it [00:00, 112.73it/s]
final accuracy: 0.5
```

- $lr = 0.0001$, loss小幅提高, 准确率降为0.9

```
[epoch9: 20/25] train loss: 0.904206 accuracy: 0.750000
[epoch9: 21/25] train loss: 0.919298 accuracy: 0.750000
[epoch9: 22/25] train loss: 1.176342 accuracy: 0.500000
[epoch9: 23/25] train loss: 0.975900 accuracy: 0.875000
[epoch9: 24/25] train loss: 0.710245 accuracy: 1.000000
[epoch9] varify loss: 0.769457 accuracy: 1.000000
5it [00:00, 115.20it/s]
final accuracy: 0.9
```

- $lr = 0.00001$, loss巨幅提高, 准确率降为0.55

```
[epoch9: 20/25] train loss: 1.248382 accuracy: 0.500000
[epoch9: 21/25] train loss: 1.294082 accuracy: 0.375000
[epoch9: 22/25] train loss: 1.527633 accuracy: 0.125000
[epoch9: 23/25] train loss: 1.155979 accuracy: 0.500000
[epoch9: 24/25] train loss: 1.315341 accuracy: 0.375000
[epoch9] varify loss: 1.335223 accuracy: 0.250000
5it [00:00, 86.31it/s]
final accuracy: 0.55
```

Adam

- $lr = 0.3$, loss大幅提高, 准确率降为0.75

```
[epoch9: 20/25] train loss: 0.783011 accuracy: 0.625000
[epoch9: 21/25] train loss: 1.230109 accuracy: 0.125000
[epoch9: 22/25] train loss: 0.637250 accuracy: 0.750000
[epoch9: 23/25] train loss: 1.052889 accuracy: 0.625000
[epoch9: 24/25] train loss: 1.315385 accuracy: 0.375000
[epoch9] varify loss: 0.903502 accuracy: 0.750000
5it [00:00, 113.21it/s]
final accuracy: 0.75
```

- $lr = 0.5$, loss巨幅提高, 准确率降为0.45

```
[epoch9: 20/25] train loss: 1.255305 accuracy: 0.375000
[epoch9: 21/25] train loss: 0.506613 accuracy: 0.750000
[epoch9: 22/25] train loss: 1.308614 accuracy: 0.500000
[epoch9: 23/25] train loss: 1.592024 accuracy: 0.500000
[epoch9: 24/25] train loss: 0.879993 accuracy: 0.500000
[epoch9] varify loss: 0.899865 accuracy: 0.500000
5it [00:00, 108.80it/s]
final accuracy: 0.45
```

- $lr = 0.0001$, loss小幅提高, 准确率无变化

```
[epoch9: 20/25] train loss: 0.074201 accuracy: 1.000000
[epoch9: 21/25] train loss: 0.034986 accuracy: 1.000000
[epoch9: 22/25] train loss: 0.135791 accuracy: 1.000000
[epoch9: 23/25] train loss: 0.714878 accuracy: 0.625000
[epoch9: 24/25] train loss: 0.113916 accuracy: 1.000000
[epoch9] verify loss: 0.066020 accuracy: 1.000000
5it [00:00, 114.13it/s]
final accuracy: 1.0
```

- $lr = 0.00001$, loss小幅提高, 准确率无变化

```
[epoch9: 20/25] train loss: 0.686566 accuracy: 0.750000
[epoch9: 21/25] train loss: 0.345263 accuracy: 1.000000
[epoch9: 22/25] train loss: 0.488561 accuracy: 1.000000
[epoch9: 23/25] train loss: 0.892405 accuracy: 0.750000
[epoch9: 24/25] train loss: 0.610329 accuracy: 0.625000
[epoch9] verify loss: 0.379531 accuracy: 1.000000
5it [00:00, 92.77it/s]
final accuracy: 1.0
```

ps: 每次训练准确率有所不同, 我是roll了很多次取众数的

看来SGD在学习率过大或过小时表现都不好, Adam在学习率过大时表现不好, 在过小时表现仍然挺不错

取消TransformNet

```
[epoch9: 20/25] train loss: 0.011674 accuracy: 1.000000
[epoch9: 21/25] train loss: 0.005669 accuracy: 1.000000
[epoch9: 22/25] train loss: 0.105774 accuracy: 1.000000
[epoch9: 23/25] train loss: 0.005478 accuracy: 1.000000
[epoch9: 24/25] train loss: 0.150765 accuracy: 1.000000
[epoch9] verify loss: 0.001311 accuracy: 1.000000
5it [00:00, 166.60it/s]
final accuracy: 1.0
```

loss基本不变, 准确率无变化

可能是数据集的样本量过小的原因