一. 初始模型与参数
• 模型构建包含卷积、池化、Dropout、全连接层，卷积、池化层激活函数采用relu，全连接层激活
  函数采用softmax_cross_entropy
• 模型参数：
    - kernel_size=[5,5]
    - pool_size=[2,2]
    - padding='same'
    - strides=[1,1]
    - 初始化方式
    -
• 超参数：
    - 学习率：0.01
    - 正则化：L2
    - 正则化惩罚因子：
    - 优化器: mini_batch
    - batch_size = 100
运行结果：

step 100, entropy loss: 1.849904, l2_loss: 790.795227, total loss: 1.905260
0.68

step 200, entropy loss: 0.709117, l2_loss: 792.926086, total loss: 0.764621
0.8

step 300, entropy loss: 0.452408, l2_loss: 793.878540, total loss: 0.507980
0.88

step 400, entropy loss: 0.330668, l2_loss: 794.399841, total loss: 0.386276
0.89

step 500, entropy loss: 0.281191, l2_loss: 794.775085, total loss: 0.336826
0.94

step 600, entropy loss: 0.374945, l2_loss: 795.076111, total loss: 0.430600
0.92

step 700, entropy loss: 0.231746, l2_loss: 795.308899, total loss: 0.287418
0.93

step 800, entropy loss: 0.239418, l2_loss: 795.549622, total loss: 0.295107
0.94

step 900, entropy loss: 0.106085, l2_loss: 795.770691, total loss: 0.161789
0.98

step 1000, entropy loss: 0.175273, l2_loss: 795.962891, total loss: 0.230991
0.95
0.9454

step 1100, entropy loss: 0.124797, l2_loss: 796.131958, total loss: 0.180526
0.97

step 1200, entropy loss: 0.134832, l2_loss: 796.253418, total loss: 0.190570
0.99

step 1300, entropy loss: 0.082072, l2_loss: 796.392334, total loss: 0.137819
0.99

step 1400, entropy loss: 0.087212, l2_loss: 796.563660, total loss: 0.142971
0.99

step 1500, entropy loss: 0.099127, l2_loss: 796.668213, total loss: 0.154893

0.98

step 1600, entropy loss: 0.228102, l2_loss: 796.794128, total loss: 0.283878

0.96

step 1700, entropy loss: 0.183832, l2_loss: 796.908325, total loss: 0.239616

0.95

step 1800, entropy loss: 0.056207, l2_loss: 797.020142, total loss: 0.111998

1.0

step 1900, entropy loss: 0.089802, l2_loss: 797.092041, total loss: 0.145598

0.98

step 2000, entropy loss: 0.157577, l2_loss: 797.173096, total loss: 0.213379

0.98

0.9672

step 2100, entropy loss: 0.115989, l2_loss: 797.248230, total loss: 0.171797

0.97

step 2200, entropy loss: 0.071114, l2_loss: 797.323730, total loss: 0.126927

0.99

step 2300, entropy loss: 0.094903, l2_loss: 797.418457, total loss: 0.150723

0.99

step 2400, entropy loss: 0.092348, l2_loss: 797.484131, total loss: 0.148172

0.98

step 2500, entropy loss: 0.155914, l2_loss: 797.534607, total loss: 0.211742

0.97

step 2600, entropy loss: 0.302149, l2_loss: 797.601440, total loss: 0.357981

0.95

step 2700, entropy loss: 0.082496, l2_loss: 797.666870, total loss: 0.138333

0.99

step 2800, entropy loss: 0.067962, l2_loss: 797.711670, total loss: 0.123802

0.98

step 2900, entropy loss: 0.164072, l2_loss: 797.770447, total loss: 0.219916

0.95

step 3000, entropy loss: 0.050256, l2_loss: 797.783813, total loss: 0.106101

0.98

0.9758

二. 模型参数调整

1. 初始化为0.01并采用动态调整学习率

运行结果：

step 100, entropy loss: 1.850278, l2_loss: 791.384399, total loss: 1.905675

0.71

step 200, entropy loss: 0.713405, l2_loss: 793.432678, total loss: 0.768946

0.84

step 300, entropy loss: 0.319187, l2_loss: 794.421509, total loss: 0.374796

0.93

step 400, entropy loss: 0.510379, l2_loss: 794.953613, total loss: 0.566026

0.91

step 500, entropy loss: 0.246463, l2_loss: 795.365967, total loss: 0.302138
0.95
step 600, entropy loss: 0.257614, l2_loss: 795.654846, total loss: 0.313310
0.92
step 700, entropy loss: 0.177166, l2_loss: 795.949097, total loss: 0.232883
0.96
step 800, entropy loss: 0.243096, l2_loss: 796.152405, total loss: 0.298826
0.95
step 900, entropy loss: 0.247563, l2_loss: 796.391113, total loss: 0.303311
0.96
step 1000, entropy loss: 0.095748, l2_loss: 796.520691, total loss: 0.151504
0.98
0.9497
step 1100, entropy loss: 0.187835, l2_loss: 796.695984, total loss: 0.243604
0.95
step 1200, entropy loss: 0.146277, l2_loss: 796.859070, total loss: 0.202057
0.97
step 1300, entropy loss: 0.306683, l2_loss: 797.011658, total loss: 0.362474
0.93
step 1400, entropy loss: 0.078561, l2_loss: 797.163513, total loss: 0.134363
1.0
step 1500, entropy loss: 0.137630, l2_loss: 797.291870, total loss: 0.193441
0.99
step 1600, entropy loss: 0.266665, l2_loss: 797.418030, total loss: 0.322484
0.93
step 1700, entropy loss: 0.143067, l2_loss: 797.538391, total loss: 0.198895
0.97
step 1800, entropy loss: 0.129760, l2_loss: 797.625000, total loss: 0.185594
0.99
step 1900, entropy loss: 0.135627, l2_loss: 797.747986, total loss: 0.191469
0.97
step 2000, entropy loss: 0.095492, l2_loss: 797.828247, total loss: 0.151340
0.98
0.9662
step 2100, entropy loss: 0.114843, l2_loss: 797.928223, total loss: 0.170698
0.97
step 2200, entropy loss: 0.039386, l2_loss: 797.989807, total loss: 0.095246
1.0
step 2300, entropy loss: 0.088655, l2_loss: 798.078796, total loss: 0.144521
0.98
step 2400, entropy loss: 0.146738, l2_loss: 798.149109, total loss: 0.202609
0.95
step 2500, entropy loss: 0.087545, l2_loss: 798.219788, total loss: 0.143420
0.97
step 2600, entropy loss: 0.053545, l2_loss: 798.285889, total loss: 0.109425

0.99

step 2700, entropy loss: 0.102562, l2_loss: 798.347107, total loss: 0.158446

0.99

step 2800, entropy loss: 0.039657, l2_loss: 798.390503, total loss: 0.095544

1.0

step 2900, entropy loss: 0.045832, l2_loss: 798.460083, total loss: 0.101724

0.99

step 3000, entropy loss: 0.119970, l2_loss: 798.496216, total loss: 0.175865

0.98

0.9772

运行结果发现，单个batch的准确率最高可以到1，每10个batch的平均准确率最后到达了97.72%。下面继续针对其他参数进一步调整。

2. 正则化惩罚因子调整，根据之前学习内容，计算出最佳因子为4e–5

运行结果：

step 100, entropy loss: 1.788078, l2_loss: 791.092957, total loss: 1.819722

0.77

step 200, entropy loss: 0.550500, l2_loss: 793.152893, total loss: 0.582226

0.87

step 300, entropy loss: 0.302877, l2_loss: 794.065430, total loss: 0.334640

0.94

step 400, entropy loss: 0.480698, l2_loss: 794.574341, total loss: 0.512481

0.87

step 500, entropy loss: 0.444423, l2_loss: 795.015076, total loss: 0.476223

0.9

step 600, entropy loss: 0.273977, l2_loss: 795.325623, total loss: 0.305790

0.94

step 700, entropy loss: 0.288855, l2_loss: 795.597168, total loss: 0.320679

0.96

step 800, entropy loss: 0.238980, l2_loss: 795.896423, total loss: 0.270816

0.93

step 900, entropy loss: 0.277348, l2_loss: 796.147217, total loss: 0.309194

0.96

step 1000, entropy loss: 0.211008, l2_loss: 796.367249, total loss: 0.242862

0.95

0.9309

step 1100, entropy loss: 0.215767, l2_loss: 796.585022, total loss: 0.247631

0.96

step 1200, entropy loss: 0.109165, l2_loss: 796.786438, total loss: 0.141036

0.98

step 1300, entropy loss: 0.192210, l2_loss: 796.995483, total loss: 0.224090

0.96

step 1400, entropy loss: 0.143750, l2_loss: 797.176880, total loss: 0.175637

0.98

step 1500, entropy loss: 0.160150, l2_loss: 797.335754, total loss: 0.192044
0.97
step 1600, entropy loss: 0.180469, l2_loss: 797.480347, total loss: 0.212368
0.95
step 1700, entropy loss: 0.171942, l2_loss: 797.665771, total loss: 0.203849
0.97
step 1800, entropy loss: 0.139911, l2_loss: 797.822205, total loss: 0.171824
0.98
step 1900, entropy loss: 0.174031, l2_loss: 797.980530, total loss: 0.205951
0.97
step 2000, entropy loss: 0.059516, l2_loss: 798.112305, total loss: 0.091440
0.99
0.9665
step 2100, entropy loss: 0.171978, l2_loss: 798.283203, total loss: 0.203910
0.96
step 2200, entropy loss: 0.156063, l2_loss: 798.412048, total loss: 0.188000
0.95
step 2300, entropy loss: 0.059024, l2_loss: 798.554565, total loss: 0.090966
1.0
step 2400, entropy loss: 0.204444, l2_loss: 798.682678, total loss: 0.236391
0.95
step 2500, entropy loss: 0.055232, l2_loss: 798.790466, total loss: 0.087184
1.0
step 2600, entropy loss: 0.092282, l2_loss: 798.900391, total loss: 0.124238
0.99
step 2700, entropy loss: 0.058093, l2_loss: 799.029175, total loss: 0.090054
0.99
step 2800, entropy loss: 0.141317, l2_loss: 799.153381, total loss: 0.173283
0.98
step 2900, entropy loss: 0.121015, l2_loss: 799.245972, total loss: 0.152985
0.96
step 3000, entropy loss: 0.067800, l2_loss: 799.354004, total loss: 0.099774
1.0
0.9741
改进不大，改了回来，尝试其他调整。

3. 更换各层参数初始化方式，默认为glorot_uniform，改为TruncatedNormal初始化
更换偏执初始值，默认为0，改为TruncatedNormal初始化1
运行结果：
step 100, entropy loss: 0.846743, l2_loss: 3094.337646, total loss: 0.970516
0.81
step 200, entropy loss: 0.436098, l2_loss: 3095.417969, total loss: 0.559915
0.88
step 300, entropy loss: 0.394600, l2_loss: 3095.850342, total loss: 0.518434
0.9

step 400, entropy loss: 0.182623, l2_loss: 3096.116211, total loss: 0.306467
0.97
step 500, entropy loss: 0.277338, l2_loss: 3096.274414, total loss: 0.401189
0.93
step 600, entropy loss: 0.293917, l2_loss: 3096.358398, total loss: 0.417771
0.93
step 700, entropy loss: 0.296232, l2_loss: 3096.433594, total loss: 0.420090
0.94
step 800, entropy loss: 0.177566, l2_loss: 3096.433350, total loss: 0.301424
0.95
step 900, entropy loss: 0.125355, l2_loss: 3096.464844, total loss: 0.249213
0.97
step 1000, entropy loss: 0.101101, l2_loss: 3096.473877, total loss: 0.224960
0.99
0.9566
step 1100, entropy loss: 0.146978, l2_loss: 3096.460693, total loss: 0.270836
0.95
step 1200, entropy loss: 0.122043, l2_loss: 3096.454834, total loss: 0.245901
0.97
step 1300, entropy loss: 0.158982, l2_loss: 3096.438477, total loss: 0.282839
0.97
step 1400, entropy loss: 0.125706, l2_loss: 3096.381104, total loss: 0.249561
0.95
step 1500, entropy loss: 0.127103, l2_loss: 3096.344971, total loss: 0.250957
0.96
step 1600, entropy loss: 0.134086, l2_loss: 3096.304932, total loss: 0.257938
0.98
step 1700, entropy loss: 0.078360, l2_loss: 3096.268555, total loss: 0.202210
1.0
step 1800, entropy loss: 0.080246, l2_loss: 3096.218750, total loss: 0.204094
0.98
step 1900, entropy loss: 0.081333, l2_loss: 3096.165039, total loss: 0.205179
0.99
step 2000, entropy loss: 0.099289, l2_loss: 3096.099854, total loss: 0.223133
0.98
0.9707
step 2100, entropy loss: 0.042365, l2_loss: 3096.008057, total loss: 0.166205
1.0
step 2200, entropy loss: 0.045788, l2_loss: 3095.942871, total loss: 0.169625
0.99
step 2300, entropy loss: 0.046375, l2_loss: 3095.884521, total loss: 0.170211
1.0
step 2400, entropy loss: 0.050057, l2_loss: 3095.775879, total loss: 0.173888
1.0
step 2500, entropy loss: 0.213412, l2_loss: 3095.652832, total loss: 0.337238

0.98

step 2600, entropy loss: 0.044951, l2_loss: 3095.570068, total loss: 0.168774
1.0

step 2700, entropy loss: 0.113245, l2_loss: 3095.483398, total loss: 0.237065
0.96

step 2800, entropy loss: 0.082331, l2_loss: 3095.388916, total loss: 0.206146
0.98

step 2900, entropy loss: 0.053906, l2_loss: 3095.284180, total loss: 0.177717
0.98

step 3000, entropy loss: 0.059039, l2_loss: 3095.184814, total loss: 0.182846
1.0
0.9778

效果有所提升，继续调整。
4.减小卷积核高度和宽度，调整为[4，4]
运行结果：
step 100, entropy loss: 1.750786, l2_loss: 3074.357422, total loss: 1.965991
0.73

step 200, entropy loss: 0.616157, l2_loss: 3076.067139, total loss: 0.831481
0.87

step 300, entropy loss: 0.385049, l2_loss: 3076.653809, total loss: 0.600415
0.94

step 400, entropy loss: 0.300062, l2_loss: 3076.840820, total loss: 0.515441
0.95

step 500, entropy loss: 0.312332, l2_loss: 3076.846680, total loss: 0.527711
0.93

step 600, entropy loss: 0.333244, l2_loss: 3076.790039, total loss: 0.548619
0.93

step 700, entropy loss: 0.217016, l2_loss: 3076.673340, total loss: 0.432383
0.95

step 800, entropy loss: 0.386022, l2_loss: 3076.558105, total loss: 0.601381
0.93

step 900, entropy loss: 0.056532, l2_loss: 3076.386963, total loss: 0.271879
1.0

step 1000, entropy loss: 0.330344, l2_loss: 3076.225098, total loss: 0.545679
0.92
0.9535

step 1100, entropy loss: 0.180340, l2_loss: 3076.010742, total loss: 0.395661
0.94

step 1200, entropy loss: 0.217335, l2_loss: 3075.837402, total loss: 0.432643
0.95

step 1300, entropy loss: 0.134846, l2_loss: 3075.642822, total loss: 0.350141
0.97

step 1400, entropy loss: 0.194546, l2_loss: 3075.429688, total loss: 0.409826
0.95

step 1500, entropy loss: 0.158567, l2_loss: 3075.213379, total loss: 0.373832
0.98
step 1600, entropy loss: 0.136977, l2_loss: 3074.950195, total loss: 0.352224
0.98
step 1700, entropy loss: 0.161638, l2_loss: 3074.709961, total loss: 0.376867
0.98
step 1800, entropy loss: 0.088245, l2_loss: 3074.474121, total loss: 0.303458
1.0
step 1900, entropy loss: 0.124861, l2_loss: 3074.239258, total loss: 0.340058
0.97
step 2000, entropy loss: 0.197836, l2_loss: 3073.986084, total loss: 0.413015
0.95
0.9667
step 2100, entropy loss: 0.161862, l2_loss: 3073.736084, total loss: 0.377023
0.97
step 2200, entropy loss: 0.124641, l2_loss: 3073.447510, total loss: 0.339782
0.97
step 2300, entropy loss: 0.087380, l2_loss: 3073.209229, total loss: 0.302504
0.99
step 2400, entropy loss: 0.167305, l2_loss: 3072.937988, total loss: 0.382410
0.96
step 2500, entropy loss: 0.093710, l2_loss: 3072.674316, total loss: 0.308797
0.97
step 2600, entropy loss: 0.111491, l2_loss: 3072.392090, total loss: 0.326558
0.98
step 2700, entropy loss: 0.144210, l2_loss: 3072.102783, total loss: 0.359257
0.97
step 2800, entropy loss: 0.065900, l2_loss: 3071.821289, total loss: 0.280928
0.99
step 2900, entropy loss: 0.076941, l2_loss: 3071.546875, total loss: 0.291949
0.99
step 3000, entropy loss: 0.079311, l2_loss: 3071.277344, total loss: 0.294301
0.98
0.9767
5. 结果差别不大，尝试调整卷积核和神经元数量，增加一倍
运行结果：
step 100, entropy loss: 0.523903, l2_loss: 12288.213867, total loss: 1.384079
0.91
step 200, entropy loss: 0.596091, l2_loss: 12287.519531, total loss: 1.456218
0.83
step 300, entropy loss: 0.347491, l2_loss: 12286.343750, total loss: 1.207535
0.95
step 400, entropy loss: 0.191921, l2_loss: 12285.023438, total loss: 1.051872
0.95
step 500, entropy loss: 0.133618, l2_loss: 12283.667969, total loss: 0.993475

0.98

step 600, entropy loss: 0.177202, l2_loss: 12282.270508, total loss: 1.036961

0.95

step 700, entropy loss: 0.113485, l2_loss: 12280.831055, total loss: 0.973143

0.99

step 800, entropy loss: 0.153801, l2_loss: 12279.405273, total loss: 1.013359

0.95

step 900, entropy loss: 0.052813, l2_loss: 12277.944336, total loss: 0.912269

1.0

step 1000, entropy loss: 0.146940, l2_loss: 12276.464844, total loss: 1.006293

0.97

0.9586

step 1100, entropy loss: 0.151878, l2_loss: 12274.969727, total loss: 1.011125

0.98

step 1200, entropy loss: 0.041367, l2_loss: 12273.504883, total loss: 0.900512

1.0

step 1300, entropy loss: 0.130705, l2_loss: 12272.010742, total loss: 0.989746

0.98

step 1400, entropy loss: 0.145203, l2_loss: 12270.517578, total loss: 1.004139

0.98

step 1500, entropy loss: 0.153846, l2_loss: 12268.981445, total loss: 1.012675

0.98

step 1600, entropy loss: 0.085029, l2_loss: 12267.492188, total loss: 0.943754

0.99

step 1700, entropy loss: 0.104557, l2_loss: 12265.948242, total loss: 0.963173

1.0

step 1800, entropy loss: 0.171715, l2_loss: 12264.438477, total loss: 1.030226

0.96

step 1900, entropy loss: 0.075895, l2_loss: 12262.889648, total loss: 0.934298

1.0

step 2000, entropy loss: 0.098639, l2_loss: 12261.345703, total loss: 0.956933

1.0

0.9775

step 2100, entropy loss: 0.099836, l2_loss: 12259.805664, total loss: 0.958022

0.99

step 2200, entropy loss: 0.110878, l2_loss: 12258.273438, total loss: 0.968957

0.97

step 2300, entropy loss: 0.085663, l2_loss: 12256.696289, total loss: 0.943632

0.98

step 2400, entropy loss: 0.086304, l2_loss: 12255.136719, total loss: 0.944164

0.99

step 2500, entropy loss: 0.059527, l2_loss: 12253.578125, total loss: 0.917278

1.0

step 2600, entropy loss: 0.028112, l2_loss: 12252.019531, total loss: 0.885753

1.0

step 2700, entropy loss: 0.106691, l2_loss: 12250.431641, total loss: 0.964221
0.99
step 2800, entropy loss: 0.051075, l2_loss: 12248.843750, total loss: 0.908494
1.0
step 2900, entropy loss: 0.081621, l2_loss: 12247.258789, total loss: 0.938929
0.99
step 3000, entropy loss: 0.028166, l2_loss: 12245.669922, total loss: 0.885363
1.0
0.9812