simpleconvnet2.py

# coding: utf-8

import sys, os

sys.path.append(os.pardir)  # 부모 디렉터리의 파일을 가져올 수 있도록 설정

import pickle

import numpy as np

from collections import OrderedDict

from common.layers import \*

from common.gradient import numerical\_gradient

class SimpleConvNet:

    def \_\_init\_\_(self, input\_dim=(1, 28, 28),

                 conv\_param={'filter\_num':30, 'filter\_size':5, 'pad':0, 'stride':1},

                 hidden\_size=100, output\_size=10, weight\_init\_std=0.01):  # 변수명 수정

        filter\_num = conv\_param['filter\_num']

        filter\_size = conv\_param['filter\_size']

        filter\_pad = conv\_param['pad']

        filter\_stride = conv\_param['stride']

        input\_size = input\_dim[1]

        conv\_output\_size = (input\_size - filter\_size + 2\*filter\_pad) / filter\_stride + 1

        pool\_output\_size = int(filter\_num \* (conv\_output\_size/2) \* (conv\_output\_size/2))

        # 가중치 초기화

        self.params = {}

        self.params['W1'] = weight\_init\_std \* \

                            np.random.randn(filter\_num, input\_dim[0], filter\_size, filter\_size)

        self.params['b1'] = np.zeros(filter\_num)

        self.params['W2'] = weight\_init\_std \* \

                            np.random.randn(pool\_output\_size, hidden\_size)

        self.params['b2'] = np.zeros(hidden\_size)

        self.params['W3'] = weight\_init\_std \* \

                            np.random.randn(hidden\_size, output\_size)

        self.params['b3'] = np.zeros(output\_size)

        # 계층 생성

        self.layers = OrderedDict()

        self.layers['Conv1'] = Convolution(self.params['W1'], self.params['b1'],

                                           conv\_param['stride'], conv\_param['pad'])

        self.layers['Relu1'] = Relu()

        self.layers['Pool1'] = Pooling(pool\_h=2, pool\_w=2, stride=2)

        self.layers['Affine1'] = Affine(self.params['W2'], self.params['b2'])

        self.layers['Relu2'] = Relu()

        self.layers['Affine2'] = Affine(self.params['W3'], self.params['b3'])

        self.last\_layer = SoftmaxWithLoss()

    def predict(self, x):

        for layer in self.layers.values():

            x = layer.forward(x)

        return x

    def loss(self, x, t):

        y = self.predict(x)

        return self.last\_layer.forward(y, t)

    def accuracy(self, x, t, batch\_size=100):

        if t.ndim != 1 : t = np.argmax(t, axis=1)

        acc = 0.0

        for i in range(int(x.shape[0] / batch\_size)):

            tx = x[i\*batch\_size:(i+1)\*batch\_size]

            tt = t[i\*batch\_size:(i+1)\*batch\_size]

            y = self.predict(tx)

            y = np.argmax(y, axis=1)

            acc += np.sum(y == tt)

        return acc / x.shape[0]

    def numerical\_gradient(self, x, t):

        loss\_w = lambda w: self.loss(x, t)

        grads = {}

        for idx in (1, 2, 3):

            grads['W' + str(idx)] = numerical\_gradient(loss\_w, self.params['W' + str(idx)])

            grads['b' + str(idx)] = numerical\_gradient(loss\_w, self.params['b' + str(idx)])

        return grads

    def gradient(self, x, t):

        # forward

        self.loss(x, t)

        # backward

        dout = 1

        dout = self.last\_layer.backward(dout)

        layers = list(self.layers.values())

        layers.reverse()

        for layer in layers:

            dout = layer.backward(dout)

        # 결과 저장

        grads = {}

        grads['W1'], grads['b1'] = self.layers['Conv1'].dW, self.layers['Conv1'].db

        grads['W2'], grads['b2'] = self.layers['Affine1'].dW, self.layers['Affine1'].db

        grads['W3'], grads['b3'] = self.layers['Affine2'].dW, self.layers['Affine2'].db

        return grads

    def save\_params(self, file\_name="params.pkl"):

        params = {}

        for key, val in self.params.items():

            params[key] = val

        with open(file\_name, 'wb') as f:

            pickle.dump(params, f)

    def load\_params(self, file\_name="params.pkl"):

        with open(file\_name, 'rb') as f:

            params = pickle.load(f)

        for key, val in params.items():

            self.params[key] = val

        for i, key in enumerate(['Conv1', 'Affine1', 'Affine2']):

            self.layers[key].W = self.params['W' + str(i+1)]

            self.layers[key].b = self.params['b' + str(i+1)]

train\_cnn.py

# coding: utf-8

import sys, os

sys.path.append(os.pardir)  # 부모 디렉터리의 파일을 가져올 수 있도록 설정

import numpy as np

import matplotlib.pyplot as plt

from dataset.fasion\_mnist import load\_mnist

from simpleconvnet2 import SimpleConvNet

from common.trainer import Trainer

# 데이터 읽기

(x\_train, t\_train), (x\_test, t\_test) = load\_mnist(flatten=False)

# 시간이 오래 걸릴 경우 데이터를 줄인다.

x\_train, t\_train = x\_train[:5000], t\_train[:5000]

x\_test, t\_test = x\_test[:1000], t\_test[:1000]

max\_epochs = 20

network = SimpleConvNet(input\_dim=(1,28,28),

                        conv\_param = {'filter\_num': 32, 'filter\_size': 5, 'pad': 0, 'stride': 1},

                        hidden\_size=256, output\_size=10, weight\_init\_std=0.01)

trainer = Trainer(network, x\_train, t\_train, x\_test, t\_test,

                  epochs=max\_epochs, mini\_batch\_size=100,

                  optimizer='Adam', optimizer\_param={'lr': 0.001},

                  evaluate\_sample\_num\_per\_epoch=1000)

trainer.train()

# 매개변수 보존

network.save\_params("params.pkl")

print("Saved Network Parameters!")

# 그래프 그리기

markers = {'train': 'o', 'test': 's'}

x = np.arange(max\_epochs)

plt.plot(x, trainer.train\_acc\_list, marker='o', label='train', markevery=2)

plt.plot(x, trainer.test\_acc\_list, marker='s', label='test', markevery=2)

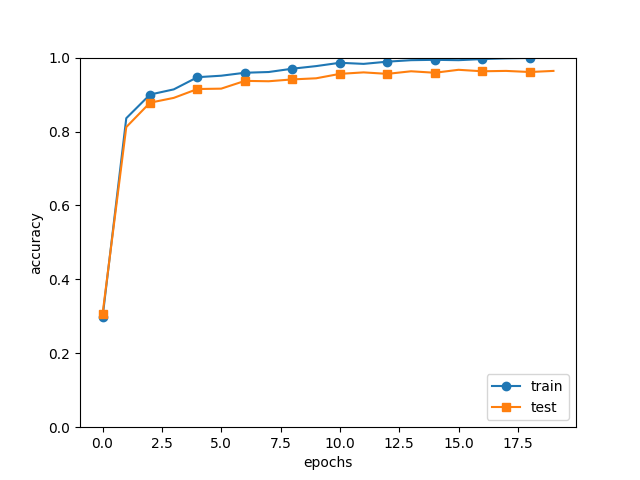
plt.xlabel("epochs")

plt.ylabel("accuracy")

plt.ylim(0, 1.0)

plt.legend(loc='lower right')

plt.show()



터미널 로그

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| --- |
| train loss:1.655565020705263  train loss:1.5612756907455403  train loss:1.4585565355572834  train loss:1.2870372785356456  train loss:1.1865707290576069  train loss:1.201578415249302  train loss:1.1520044041292181  train loss:0.9922032960074517  train loss:1.0237513171569355  train loss:0.8529673405444579  train loss:0.9730841255006724  train loss:0.6639623808582593  train loss:0.8021616181286904  train loss:0.6600843023683436  train loss:0.6247525118514222  train loss:0.7665621740903801  train loss:0.4949064582269804  train loss:0.6242407698503913  train loss:0.49830810936065156  train loss:0.5229569110564131  train loss:0.5791054054725078  train loss:0.46922702911403585  train loss:0.42852399813685893  train loss:0.6446735245788626  train loss:0.5703158994201106  train loss:0.6595882060541696  train loss:0.4358446785034126  train loss:0.561120505561482  train loss:0.7692922613678854  train loss:0.4550538698384174  train loss:0.44976007305502463  train loss:0.41405555096053503  train loss:0.504489285363871  train loss:0.42274515822952957  train loss:0.47779356807878437  train loss:0.4752809528201666  train loss:0.45331419004713713  train loss:0.4203434081258399  === epoch:2, train acc:0.836, test acc:0.812 ===  train loss:0.48287478656060157  train loss:0.39664770268557153  train loss:0.31456944934203707  train loss:0.5127149056948094  train loss:0.3593224532519468  train loss:0.36755391375337176  train loss:0.3495835986603479  train loss:0.4158473105160699  train loss:0.32152638782854254  train loss:0.3351935316310425  train loss:0.3386612951325979  train loss:0.18844282702712958  train loss:0.26912271377640357  train loss:0.3121777776667325  train loss:0.20029675231592506  train loss:0.49685431006929187  train loss:0.35712573506052137  train loss:0.29303954388827247  train loss:0.28268623504814755  train loss:0.43256264064371464  train loss:0.3532789047860303  train loss:0.21909573044062217  train loss:0.2987549804577581  train loss:0.3410657858441422  train loss:0.20199413035215133  train loss:0.2821395624715639  train loss:0.5090209063010435  train loss:0.3952273210933893  train loss:0.3167399422840474  train loss:0.4400894246092143  train loss:0.480518877747534  train loss:0.261729055522316  train loss:0.24563443288093978  train loss:0.24588134257680302  train loss:0.3673054235311165  train loss:0.23480324881192793  train loss:0.3079535703514809  train loss:0.4086777089890201  train loss:0.2689476769178987  train loss:0.3597453652378042  train loss:0.24789994142983843  train loss:0.4943301934869385  train loss:0.2421699104974082  train loss:0.18983168547296891  train loss:0.21661684349064333  train loss:0.37133725145715885  train loss:0.2406967247806861  train loss:0.324918830455651  train loss:0.3952273759144299  train loss:0.21899109941422995  === epoch:3, train acc:0.9, test acc:0.878 ===  train loss:0.2750013989805629  train loss:0.24291276241555315  train loss:0.3350853128435793  train loss:0.29907725898111137  train loss:0.25918216890478457  train loss:0.3574599361062101  train loss:0.5136820178214928  train loss:0.3083360869831462  train loss:0.3778759413399652  train loss:0.2558559432648089  train loss:0.34440379342648586  train loss:0.14426695877988857  train loss:0.19971915235402327  train loss:0.32518134483788863  train loss:0.23570357931035546  train loss:0.2235755391059305  train loss:0.14430484798936344  train loss:0.24909496915958637  train loss:0.26715307800452925  train loss:0.26275512187590555  train loss:0.34696169719930076  train loss:0.23039420792342058  train loss:0.2369885026392811  train loss:0.25255821778887294  train loss:0.2145247014439474  train loss:0.22293786143100808  train loss:0.21154320043925628  train loss:0.3551378221720762  train loss:0.2862347756442027  train loss:0.18399816189892518  train loss:0.22313438154914864  train loss:0.20178108744918874  train loss:0.23824391855829044  train loss:0.1364925076874601  train loss:0.24139820617345736  train loss:0.16137199956054513  train loss:0.1916070695401724  train loss:0.25605850285614673  train loss:0.18004184146592134  train loss:0.2069808692277815  train loss:0.25279228295525474  train loss:0.24571581261173805  train loss:0.19137271077104034  train loss:0.18850961536852293  train loss:0.09537895840680026  train loss:0.21420854389981617  train loss:0.35243048008730155  train loss:0.20304597229454696  train loss:0.14320999174759363  train loss:0.19578997047641714  === epoch:4, train acc:0.914, test acc:0.891 ===  train loss:0.22523647395747026  train loss:0.16075152090059552  train loss:0.2160189685500233  train loss:0.2960884850760806  train loss:0.1710423058728277  train loss:0.13971100326641672  train loss:0.19276312929871822  train loss:0.15643147203364594  train loss:0.25905019879424895  train loss:0.09740233256554957  train loss:0.18566468669926692  train loss:0.23934105967814362  train loss:0.25352643307879186  train loss:0.1656600678637354  train loss:0.16446031891634422  train loss:0.17595973043266294  train loss:0.1711391393858455  train loss:0.18185711440780009  train loss:0.16178604735854793  train loss:0.3861038493559738  train loss:0.21356894394103812  train loss:0.10125251140610594  train loss:0.0884653685875568  train loss:0.21474737554448467  train loss:0.21718501575539265  train loss:0.23605964813303204  train loss:0.11183338516996898  train loss:0.10844558563736512  train loss:0.28016172725037125  train loss:0.17621893514253043  train loss:0.23373102648595107  train loss:0.18579159327300443  train loss:0.1879352378446844  train loss:0.10543137961225306  train loss:0.11810437165766471  train loss:0.08780036167031426  train loss:0.27520132081715976  train loss:0.09568714304506458  train loss:0.11385472947933495  train loss:0.26024531183026783  train loss:0.14701639050657492  train loss:0.06308029729343931  train loss:0.09249292526957482  train loss:0.16727598837211463  train loss:0.27901064516710533  train loss:0.21527460257396572  train loss:0.08133103141457879  train loss:0.17190928656470308  train loss:0.19573541657507104  train loss:0.13833996892606854  === epoch:5, train acc:0.947, test acc:0.915 ===  train loss:0.1767331562639304  train loss:0.07546694445357238  train loss:0.12791332850155457  train loss:0.22018597193663947  train loss:0.08422592773025013  train loss:0.16820917844169148  train loss:0.14763439948818338  train loss:0.1299441820449363  train loss:0.19206656543800052  train loss:0.27655635834997455  train loss:0.11862964263850519  train loss:0.1754077232390669  train loss:0.14980299266693162  train loss:0.13942259978914093  train loss:0.11667477180592659  train loss:0.10708807108715565  train loss:0.13833932136128688  train loss:0.18386764716500878  train loss:0.1286296325743739  train loss:0.10941434605023966  train loss:0.1858986998348518  train loss:0.18738144595001344  train loss:0.1482712696109215  train loss:0.18871603117456068  train loss:0.1078288624988147  train loss:0.1514518610533237  train loss:0.15929581870950688  train loss:0.1394987808310998  train loss:0.16899933427659103  train loss:0.18583223369279944  train loss:0.09625284887878438  train loss:0.0982323519848766  train loss:0.06795126421951297  train loss:0.14041522576682736  train loss:0.1339865043064452  train loss:0.12558617108339334  train loss:0.07266824199304439  train loss:0.18281903706555422  train loss:0.09387994261768824  train loss:0.1229250026717219  train loss:0.2812471072120683  train loss:0.24620247290411282  train loss:0.10380931258114577  train loss:0.1489843640456824  train loss:0.1813310995045713  train loss:0.1611967234454589  train loss:0.03550139236674415  train loss:0.10677129758318628  train loss:0.15192212876577474  train loss:0.07318091379025704  === epoch:6, train acc:0.951, test acc:0.916 ===  train loss:0.1583381575188071  train loss:0.1006959622951142  train loss:0.12677632400577754  train loss:0.05829521331180015  train loss:0.27816947839267664  train loss:0.17014754131621904  train loss:0.0571295397895939  train loss:0.21455288662970254  train loss:0.22709031697614296  train loss:0.14049220261288722  train loss:0.06933893038712542  train loss:0.1378826659077521  train loss:0.06395167209898817  train loss:0.22189942342508012  train loss:0.08684499188382883  train loss:0.09929236570994843  train loss:0.1578137004328837  train loss:0.1682167687460379  train loss:0.1467348617281436  train loss:0.11181311596893817  train loss:0.11625836628340412  train loss:0.10346686999495933  train loss:0.09414665362350566  train loss:0.16828568705633618  train loss:0.10553451348816133  train loss:0.07591124855682643  train loss:0.06779125380579222  train loss:0.22314786073383236  train loss:0.0928796249919706  train loss:0.2009862775848919  train loss:0.09735053392193364  train loss:0.0772039944029596  train loss:0.1347401543981549  train loss:0.12676667239171036  train loss:0.10765398539723972  train loss:0.3028025293998835  train loss:0.14494417881130395  train loss:0.15195225018334504  train loss:0.10991440910611674  train loss:0.15668658018257195  train loss:0.21204952278019604  train loss:0.10895972748094261  train loss:0.15100215419828716  train loss:0.11922449888265935  train loss:0.11775386591906971  train loss:0.1365561076193355  train loss:0.07008037108195422  train loss:0.10843651061876061  train loss:0.06439665333532595  train loss:0.11537344525829331  === epoch:7, train acc:0.959, test acc:0.937 ===  train loss:0.14415072101294246  train loss:0.12345904607845509  train loss:0.11439496595348853  train loss:0.12310366752875605  train loss:0.07982358746682024  train loss:0.09143892556940375  train loss:0.16860334512106132  train loss:0.0897591908251134  train loss:0.07100324493848266  train loss:0.1552716909090135  train loss:0.11217802345574318  train loss:0.09721993510226459  train loss:0.12426054548629702  train loss:0.1700808078313596  train loss:0.14562913420703436  train loss:0.07097808257950483  train loss:0.07736955291911332  train loss:0.1096150783824645  train loss:0.09196705309225253  train loss:0.11678712741220174  train loss:0.09964264652794531  train loss:0.13089923755313063  train loss:0.11864469620288828  train loss:0.07299544603793157  train loss:0.09061800429739626  train loss:0.14023209381205684  train loss:0.0543137357561973  train loss:0.11591373484715145  train loss:0.10262345857745321  train loss:0.12241426978613636  train loss:0.1132751344687272  train loss:0.055343207158085855  train loss:0.04638886460007529  train loss:0.03960578536349254  train loss:0.05605015389919306  train loss:0.04022652922825427  train loss:0.08560170441574451  train loss:0.06005124616610811  train loss:0.06636488174587701  train loss:0.07277720823186094  train loss:0.1141302148470003  train loss:0.05656720527633294  train loss:0.15949573170294062  train loss:0.07326187480826951  train loss:0.05169389172548916  train loss:0.0905509248783933  train loss:0.10557005285138972  train loss:0.07869680941368577  train loss:0.1206496803860759  train loss:0.09724866259425959  === epoch:8, train acc:0.961, test acc:0.936 ===  train loss:0.06016180464060048  train loss:0.17003595279678194  train loss:0.06901460915684528  train loss:0.09932419700184267  train loss:0.060096688044248614  train loss:0.0666533442282605  train loss:0.036687749140768194  train loss:0.10183442259366203  train loss:0.09936337626715432  train loss:0.055315162410899496  train loss:0.09639349336916415  train loss:0.1706838975480286  train loss:0.07392134559028461  train loss:0.07515087319160571  train loss:0.06763322391757348  train loss:0.11203413730395213  train loss:0.051437394479895024  train loss:0.07745128957024996  train loss:0.040042275857666086  train loss:0.08698308709985814  train loss:0.05637826919582512  train loss:0.13252789021913836  train loss:0.10285513010516296  train loss:0.09628296469182353  train loss:0.0809639098663507  train loss:0.06329983762345363  train loss:0.1766232967734827  train loss:0.043236620016788414  train loss:0.11264458325026014  train loss:0.06044428968285257  train loss:0.08758964932130135  train loss:0.05646798631994245  train loss:0.05028611559269132  train loss:0.18296620399387745  train loss:0.02821557718021236  train loss:0.06301994397091627  train loss:0.09790226277026871  train loss:0.038863757198043226  train loss:0.08767650607275301  train loss:0.12551007554869606  train loss:0.02521292929027244  train loss:0.04288254311484805  train loss:0.0596083790834597  train loss:0.07939833281508865  train loss:0.08171487830871445  train loss:0.11301824214756406  train loss:0.040330946150086616  train loss:0.09222910533637885  train loss:0.04466484995307689  train loss:0.06187071749593391  === epoch:9, train acc:0.97, test acc:0.941 ===  train loss:0.11444160882084149  train loss:0.0921758245621827  train loss:0.12892593573062142  train loss:0.05687231687803718  train loss:0.032989219275164634  train loss:0.0761704671691159  train loss:0.031481305884941774  train loss:0.07356544692168358  train loss:0.06060281495664725  train loss:0.029530735195270042  train loss:0.07257660515206817  train loss:0.04247180421848474  train loss:0.043584198093060314  train loss:0.026957890954644022  train loss:0.04361309685342429  train loss:0.06549221396574201  train loss:0.06061659012330833  train loss:0.07763402557341516  train loss:0.05012705188521575  train loss:0.08750542150572489  train loss:0.09492107168582636  train loss:0.05251534682657375  train loss:0.03960946107639741  train loss:0.051073187760018825  train loss:0.06440031345152206  train loss:0.05516000596163979  train loss:0.05281076711679615  train loss:0.1406948525757371  train loss:0.08102054754655069  train loss:0.10270438711238683  train loss:0.07094217346080367  train loss:0.026450642452721176  train loss:0.08569216380814938  train loss:0.04549302470778986  train loss:0.09007611451680189  train loss:0.02751737285831809  train loss:0.08242415593394224  train loss:0.07648078071660772  train loss:0.028295123621874193  train loss:0.03593663037468971  train loss:0.016341092504205578  train loss:0.11048537766181717  train loss:0.01979354954599892  train loss:0.0544014697137024  train loss:0.038902228934781194  train loss:0.03064489499623011  train loss:0.06624115705204836  train loss:0.05946588268334266  train loss:0.09469434813328861  train loss:0.047406523550006775  === epoch:10, train acc:0.977, test acc:0.944 ===  train loss:0.03774895683865876  train loss:0.04645038715697364  train loss:0.06595226459786313  train loss:0.02936477249467078  train loss:0.05083235895609916  train loss:0.04724479256228789  train loss:0.08251075215287226  train loss:0.09924525172144322  train loss:0.044818970172604965  train loss:0.05266715140266959  train loss:0.03789879233122178  train loss:0.02742937650275703  train loss:0.08052287404041994  train loss:0.015509515549972376  train loss:0.037334544083008236  train loss:0.058270849793768474  train loss:0.06129402301594206  train loss:0.0659225821808316  train loss:0.02124681079596732  train loss:0.0756674898893655  train loss:0.07701388302034136  train loss:0.07121900207830012  train loss:0.09231483788791875  train loss:0.043137631825267454  train loss:0.048591658996335454  train loss:0.07193170026653174  train loss:0.12465596848538534  train loss:0.060745279752068754  train loss:0.05960883830794013  train loss:0.02567345122342206  train loss:0.04013554935121921  train loss:0.029322911887716047  train loss:0.03310629390086694  train loss:0.07386397464371719  train loss:0.11703861963050106  train loss:0.026839030567732923  train loss:0.07298651655350309  train loss:0.07576892854344855  train loss:0.04625989297639279  train loss:0.12652881284123993  train loss:0.02876293618943827  train loss:0.021789385743584546  train loss:0.08205370665418546  train loss:0.06602137827566429  train loss:0.028707283694250577  train loss:0.07654380359350295  train loss:0.021763993627747644  train loss:0.06257846008049212  train loss:0.060387593262879624  train loss:0.015315833666430943  === epoch:11, train acc:0.986, test acc:0.956 ===  train loss:0.05118763173705337  train loss:0.02022100952138115  train loss:0.06524617210468735  train loss:0.029265525030701536  train loss:0.07155097750643416  train loss:0.02316995896172591  train loss:0.04865767833668083  train loss:0.0596493139878537  train loss:0.0541177805231111  train loss:0.034956767332247354  train loss:0.04775703064998674  train loss:0.02019487601662113  train loss:0.022110516793363625  train loss:0.03692257497869942  train loss:0.024814013096542326  train loss:0.12160497538144847  train loss:0.01733052447220757  train loss:0.03913949231790918  train loss:0.019401039062515692  train loss:0.03459462837476637  train loss:0.018355665825376927  train loss:0.02481204861303526  train loss:0.04310483459777173  train loss:0.0628470201563906  train loss:0.06492757148406261  train loss:0.02613561000516099  train loss:0.027000829570625863  train loss:0.07977697606753767  train loss:0.0234846616331059  train loss:0.031281179213225936  train loss:0.026882283401687305  train loss:0.014498329476595595  train loss:0.022774673004388825  train loss:0.024647130352799407  train loss:0.05159095261071845  train loss:0.04869492932910514  train loss:0.020420718836537396  train loss:0.015424034682818664  train loss:0.06327281339273089  train loss:0.013204372641686217  train loss:0.02033278100193879  train loss:0.03341018829956432  train loss:0.008517927221416506  train loss:0.04011110704223927  train loss:0.018167341642666084  train loss:0.016609027031104135  train loss:0.019622617979036923  train loss:0.022343181547569126  train loss:0.05226038460714267  train loss:0.024797947349125077  === epoch:12, train acc:0.983, test acc:0.96 ===  train loss:0.03916122589522149  train loss:0.042112551806090234  train loss:0.0777740554160325  train loss:0.0635449526941395  train loss:0.024290114563439217  train loss:0.04093903579884853  train loss:0.04559365616931192  train loss:0.01735923855046565  train loss:0.013315842487331496  train loss:0.055124585661548584  train loss:0.025035073943343276  train loss:0.04038825551286112  train loss:0.016562939767218666  train loss:0.02989034646980253  train loss:0.04649504836311917  train loss:0.05250833841827942  train loss:0.05275244246321487  train loss:0.03468740125113473  train loss:0.01763195935518239  train loss:0.013909067095774769  train loss:0.02447007012462556  train loss:0.018529494952788553  train loss:0.02173823449647034  train loss:0.07898427426338342  train loss:0.009469323599975365  train loss:0.045933321479116336  train loss:0.01391124249897898  train loss:0.02940989049767459  train loss:0.07597925526878456  train loss:0.03889702039082736  train loss:0.01911660174479075  train loss:0.06124798100281044  train loss:0.03656731986370569  train loss:0.06282552490513744  train loss:0.0357510163306923  train loss:0.036223296976935784  train loss:0.047909328910902514  train loss:0.00943370067649841  train loss:0.019758218934347614  train loss:0.017724149853061033  train loss:0.057152868609558205  train loss:0.028277627635277244  train loss:0.028758225237129228  train loss:0.0471471682119804  train loss:0.0326579057293643  train loss:0.027766612611566988  train loss:0.03014548188192835  train loss:0.06023158901271109  train loss:0.020508962805168864  train loss:0.08163685637438305  === epoch:13, train acc:0.989, test acc:0.956 ===  train loss:0.019655416589027017  train loss:0.0583567009366889  train loss:0.01870912292428663  train loss:0.014661606822673005  train loss:0.022071354476898696  train loss:0.014774943026958864  train loss:0.014963253198612565  train loss:0.02421558881671392  train loss:0.017012013639041482  train loss:0.019258841020374687  train loss:0.026871189154931172  train loss:0.025831802476142945  train loss:0.022820395635617947  train loss:0.022146265646684267  train loss:0.023294383064996392  train loss:0.017774838137654164  train loss:0.053093952413006004  train loss:0.009930270031006305  train loss:0.027076373363904827  train loss:0.014314342956027216  train loss:0.04983050594180742  train loss:0.0349784729258482  train loss:0.028949639459386757  train loss:0.009154081607647415  train loss:0.04000202359612355  train loss:0.04535813955468118  train loss:0.039719749861448446  train loss:0.0146531598147277  train loss:0.027079754006035746  train loss:0.017468247594383368  train loss:0.021583911367508878  train loss:0.00732085888658847  train loss:0.02761736892823013  train loss:0.023030438249534255  train loss:0.02261318669553839  train loss:0.013251376135612494  train loss:0.030983322049749962  train loss:0.01203194187685796  train loss:0.02183029995978277  train loss:0.01801939789248755  train loss:0.037210728237642196  train loss:0.016695975487375343  train loss:0.01548912577937866  train loss:0.009930522490837002  train loss:0.013105955683149241  train loss:0.014696632073984372  train loss:0.01073841012244509  train loss:0.019303451058528254  train loss:0.010337569484810983  train loss:0.011834700550931197  === epoch:14, train acc:0.993, test acc:0.963 ===  train loss:0.012706433883810951  train loss:0.008195234404199423  train loss:0.07376081946651818  train loss:0.008318503820559126  train loss:0.011234342756964081  train loss:0.007261945401217772  train loss:0.04761767551892596  train loss:0.019611070278547117  train loss:0.007513151735086706  train loss:0.010908708883795613  train loss:0.023603225976154024  train loss:0.013005706864442293  train loss:0.06640254028029968  train loss:0.018843618575687747  train loss:0.01598797520076916  train loss:0.04046898911390117  train loss:0.009897295487244098  train loss:0.018148662367769103  train loss:0.016204961987245258  train loss:0.021923775049801496  train loss:0.012186267382937347  train loss:0.025317397597361478  train loss:0.017915216084462726  train loss:0.04112017216818607  train loss:0.00960820266743732  train loss:0.014188002517323354  train loss:0.009930873516467115  train loss:0.01524814565480661  train loss:0.005449533808203894  train loss:0.01200196926752199  train loss:0.010580443093539187  train loss:0.008161989834547422  train loss:0.02221011014731475  train loss:0.022918057529847356  train loss:0.03830891338995068  train loss:0.03943971673981061  train loss:0.009787609258596746  train loss:0.026119299260105196  train loss:0.019601380156289802  train loss:0.01951480302774732  train loss:0.011069097527643616  train loss:0.011919765537808779  train loss:0.01601289552752917  train loss:0.010895976833585681  train loss:0.014249572151909758  train loss:0.04616193429116965  train loss:0.010272171572045291  train loss:0.004445386470127315  train loss:0.011306921103233851  train loss:0.012365979968096949  === epoch:15, train acc:0.994, test acc:0.959 ===  train loss:0.04527368661729919  train loss:0.026945988704939958  train loss:0.009620412836276463  train loss:0.0067830789387076755  train loss:0.03407455770664322  train loss:0.02385412046769304  train loss:0.02116420538365098  train loss:0.007639734488561193  train loss:0.007343918416560155  train loss:0.010455607911686095  train loss:0.010776657661115779  train loss:0.007076118700297338  train loss:0.011067739451059854  train loss:0.01413692955903456  train loss:0.008195133259146396  train loss:0.05993990849288216  train loss:0.009190149284195849  train loss:0.004043388262632377  train loss:0.007741099846639511  train loss:0.02660351571530523  train loss:0.019005817491689326  train loss:0.005701655001707397  train loss:0.013290648007988713  train loss:0.00928624940334675  train loss:0.009525217567016268  train loss:0.016706424151265206  train loss:0.022816957284876035  train loss:0.016689585316411692  train loss:0.012455672560911455  train loss:0.008581528358624824  train loss:0.0426029495395151  train loss:0.02126584781633759  train loss:0.014646325546407424  train loss:0.01887033473844019  train loss:0.00820722452406045  train loss:0.013029602269811456  train loss:0.020009800070954695  train loss:0.015600348682223566  train loss:0.010192092464960906  train loss:0.017791307039855774  train loss:0.023715475484235134  train loss:0.01279284435373007  train loss:0.013186394239526883  train loss:0.012677657498359593  train loss:0.019814956793187736  train loss:0.035289548095552445  train loss:0.020524006270723944  train loss:0.011868959893881356  train loss:0.025054044912782153  train loss:0.006121930923416148  === epoch:16, train acc:0.993, test acc:0.967 ===  train loss:0.033302883990778805  train loss:0.012865272153088424  train loss:0.02563962767773337  train loss:0.015727845423255612  train loss:0.00750688761248828  train loss:0.020820116564350746  train loss:0.010557082388006993  train loss:0.009699752436190178  train loss:0.010782491410922333  train loss:0.005457401796578886  train loss:0.015904105535258145  train loss:0.008662864466913962  train loss:0.014155918629259006  train loss:0.022481508791640084  train loss:0.02173023759575264  train loss:0.01751088766526991  train loss:0.005819758155008057  train loss:0.02129823200912289  train loss:0.029267847233649884  train loss:0.014350094691432266  train loss:0.006857268251965607  train loss:0.018391099091639745  train loss:0.02969964076171729  train loss:0.01205726822608632  train loss:0.013147687027517299  train loss:0.007850722888244987  train loss:0.008990408030002941  train loss:0.014277842106718452  train loss:0.009659086203128059  train loss:0.04405757658705242  train loss:0.0071812182524052925  train loss:0.012788161380890563  train loss:0.003330742409727396  train loss:0.013527119805498127  train loss:0.014362698710184207  train loss:0.013536987980197599  train loss:0.022106692824573174  train loss:0.011173518521913027  train loss:0.017540447155767514  train loss:0.006150276382904599  train loss:0.006882445634457177  train loss:0.007244943546324845  train loss:0.009678235930034423  train loss:0.00614252912684993  train loss:0.009977692377614535  train loss:0.014542227099100115  train loss:0.031002236607655866  train loss:0.03109991646871924  train loss:0.008815011062804724  train loss:0.004903814185130312  === epoch:17, train acc:0.996, test acc:0.963 ===  train loss:0.003731682390814028  train loss:0.013653523374898214  train loss:0.03733293165725232  train loss:0.007394580335399023  train loss:0.01598498629915459  train loss:0.014306869095921016  train loss:0.013895986580440023  train loss:0.006014691338202585  train loss:0.022803319796907764  train loss:0.014200142991650537  train loss:0.015305542831755841  train loss:0.01656505309918506  train loss:0.010474822981518616  train loss:0.007392282897609531  train loss:0.007733194707733657  train loss:0.009155032331338919  train loss:0.008965184419791048  train loss:0.0023046349943642956  train loss:0.00991003723874249  train loss:0.011612484246103444  train loss:0.008574192931195908  train loss:0.02347557430178743  train loss:0.01732372002665184  train loss:0.020793262946044683  train loss:0.02681541901857447  train loss:0.007769421489603011  train loss:0.005988861021130396  train loss:0.012742211913398787  train loss:0.01013776777249648  train loss:0.006048596587220693  train loss:0.005733079559706556  train loss:0.011406859980527189  train loss:0.004277331538442165  train loss:0.007851313177422563  train loss:0.025554815206568052  train loss:0.04308531680435618  train loss:0.00802731067393725  train loss:0.004772185053837823  train loss:0.005210869851972447  train loss:0.010173984477120798  train loss:0.00637029362915087  train loss:0.007923884325550534  train loss:0.008591989121082609  train loss:0.0055583978467098425  train loss:0.02328140363226697  train loss:0.03556854924088624  train loss:0.019988743975519134  train loss:0.008226457791805185  train loss:0.008763340547042529  train loss:0.010026090092395029  === epoch:18, train acc:0.998, test acc:0.964 ===  train loss:0.008852001789847139  train loss:0.013211893718210754  train loss:0.014328912548474626  train loss:0.00524686791840034  train loss:0.014910883831980288  train loss:0.006343200067203364  train loss:0.018889826602591957  train loss:0.006467565444997772  train loss:0.0066100056908839026  train loss:0.012312496096138482  train loss:0.005651906919153357  train loss:0.004151681212938266  train loss:0.005314303213304307  train loss:0.007481377058066713  train loss:0.012271445943166726  train loss:0.012611243432924933  train loss:0.013645327341419038  train loss:0.00839379917030692  train loss:0.019004771854618206  train loss:0.00758670730253598  train loss:0.005851591314534118  train loss:0.01365865423010738  train loss:0.009217247271528433  train loss:0.0065934099334440995  train loss:0.005222186332696855  train loss:0.006362968965659736  train loss:0.009237644996915203  train loss:0.009275188308423103  train loss:0.03698956051878061  train loss:0.006376460403810434  train loss:0.010409302081646152  train loss:0.006495355359192375  train loss:0.005013033680282363  train loss:0.003203965305059122  train loss:0.0036331679081871315  train loss:0.0034638408510755396  train loss:0.011278559501450326  train loss:0.0046910467715666785  train loss:0.0036397605739883166  train loss:0.0078001822687587055  train loss:0.004326861750540386  train loss:0.010144356583964962  train loss:0.0036925256335268914  train loss:0.005901932187892204  train loss:0.006723056769269201  train loss:0.004476582150283273  train loss:0.003561426885563302  train loss:0.017212444019008323  train loss:0.006040604117551829  train loss:0.003126586985811897  === epoch:19, train acc:0.999, test acc:0.961 ===  train loss:0.010048316327170374  train loss:0.002323331301830863  train loss:0.003269397715926978  train loss:0.006050755248444847  train loss:0.00890315629499221  train loss:0.008556443081631044  train loss:0.003907009654558611  train loss:0.003774805396740983  train loss:0.0046792527640713046  train loss:0.004461451335876496  train loss:0.00879017034471494  train loss:0.0030130311572697287  train loss:0.009555318862460182  train loss:0.0033965228340498517  train loss:0.011076967462993179  train loss:0.00556503864247078  train loss:0.004355977716067771  train loss:0.013372191364719779  train loss:0.004330293783030104  train loss:0.003289964999738831  train loss:0.00941313248534362  train loss:0.00511893250695095  train loss:0.004322942199477358  train loss:0.003943446364980666  train loss:0.003783056515956066  train loss:0.011350709747500898  train loss:0.0051304792791184006  train loss:0.01180651089738642  train loss:0.011598820483097915  train loss:0.022584976345120446  train loss:0.004654361763089469  train loss:0.0025788264007069643  train loss:0.003807560833484285  train loss:0.007343250999354329  train loss:0.0036456711109706334  train loss:0.0019896734643619664  train loss:0.003958459862041275  train loss:0.0063303013108067215  train loss:0.00463288338277793  train loss:0.013248932802438607  train loss:0.0024479057955587246  train loss:0.005444470797026964  train loss:0.004100737032649946  train loss:0.008612733000542088  train loss:0.008807699724185082  train loss:0.00536372932921479  train loss:0.00547649851762111  train loss:0.006418423376667743  train loss:0.005606748665635426  train loss:0.001335167089484916  === epoch:20, train acc:0.999, test acc:0.964 ===  train loss:0.0017870707206491926  train loss:0.0029161585842194847  train loss:0.013437181553056107  train loss:0.0047801995248617  train loss:0.0014121230815006406  train loss:0.002728966698378382  train loss:0.00508392081145934  train loss:0.0021256489850431676  train loss:0.0027785160704158905  train loss:0.016212332837075828  train loss:0.004175903654153577  train loss:0.011430416933773226  train loss:0.0034282206383511866  train loss:0.003698167037393495  train loss:0.005042861504825119  train loss:0.0018707728527493112  train loss:0.0025694331433879806  train loss:0.0032229255770904346  train loss:0.0052899624889588374  train loss:0.005810554665407193  train loss:0.004565176172243562  train loss:0.009869831689145687  train loss:0.0038323504492333805  train loss:0.006326648576506523  train loss:0.002582897716138186  train loss:0.006512848848851544  train loss:0.007099529068860667  train loss:0.015237428217474704  train loss:0.0019031221661252994  train loss:0.004530653448249284  train loss:0.00315924415631518  train loss:0.00305274278256817  train loss:0.01081103066125715  train loss:0.0042716993348632945  train loss:0.007749834207104994  train loss:0.004574931775760223  train loss:0.004336685551180274  train loss:0.004872531472464039  train loss:0.005399553687031059  train loss:0.003485320022192603  train loss:0.005128190734278354  train loss:0.004143203389479184  train loss:0.0011304606752731302  train loss:0.0038273436855024946  train loss:0.002559888596623478  train loss:0.010037381343690626  train loss:0.002772364988551278  train loss:0.001259999618648218  train loss:0.0024857710752820973  =============== Final Test Accuracy ===============  test acc:0.966 |