▾ One Shot Learning with Siamese Networks

This is the jupyter notebook that accompanies

▾ Imports

All the imports are defined here

```python
import os
```

```python
%matplotlib inline
import torchvision
import torchvision.datasets as dset
import torchvision.transforms as transforms
from torch.utils.data import DataLoader,Dataset
import matplotlib.pyplot as plt
import torchvision.utils
import numpy as np
import random
from PIL import Image
import torch
from torch.autograd import Variable
import PIL.ImageOps
import torch.nn as nn
from torch import optim
import torch.nn.functional as F
```

```python
!rm -r signatures
```

```
    rm: cannot remove 'signatures': No such file or directory
```

```python
#!mv Abhishek AmirKhan Amitab AnilKapoor MotherTresa training_data
!wget https://cedar.buffalo.edu/NIJ/data/signatures.rar
!unrar x signatures.rar
!mkdir training_data
!mkdir testing_data
!mkdir training_data/Author1_org
!mkdir training_data/Author1_forg
!cp signatures/full_org/original_1_* training_data/Author1_org
!cp signatures/full_forg/forgeries_1_* training_data/Author1_forg
!mkdir testing_data/Author1_org
!mkdir testing_data/Author1_forg
!cp signatures/full_org/original_1_4.png testing_data/Author1_org
!cp signatures/full_forg/forgeries_1_4.png testing_data/Author1_forg
!cp signatures/full_org/original_2_4.png testing_data/Author1_org
!cp signatures/full_forg/forgeries_2_4.png testing_data/Author1_forg
!mkdir training_data/Author2_org
!mkdir training_data/Author2_forg
!cp signatures/full_org/original_2_* training_data/Author2_org
!cp signatures/full_forg/forgeries_2_* training_data/Author2_forg
#!mv signatures/full_forg signatures/full_org training_data
#!mv training_data/Author1 training_data/Author1_orig
#!cp signatures/full_org/original_1_* training_data/Author1_org
#!mkdir training_data/Author1_org
#!cp signatures/full_forg/forgeries_1_* training_data/Author1_forg
#!rm -r training_data/Author1_orig
#!cp signatures/full_org/original_1_4.png* testing_data/
```

```
#!cp signatures/full_forg/forgeries_1_4.png testing_data/
#!mkdir testing_data/Author1_org
#!mkdir testing_data/Author1_forg
#!cp signatures/full_org/original_1_4.png testing_data/Author1_org
#!cp signatures/full_forg/forgeries_1_4.png testing_data/Author1_forg
#!cp signatures/full_org/original_2_4.png testing_data/Author1_org
#!cp signatures/full_forg/forgeries_2_4.png testing_data/Author1_forg
```

```
    Extracting  signatures/full_org/original_7_3.png              OK
    Extracting  signatures/full_org/original_7_4.png              OK
    Extracting  signatures/full_org/original_7_5.png              OK
    Extracting  signatures/full_org/original_7_6.png              OK
    Extracting  signatures/full_org/original_7_7.png              OK
    Extracting  signatures/full_org/original_7_8.png              OK
    Extracting  signatures/full_org/original_7_9.png              OK
    Extracting  signatures/full_org/original_8_1.png              OK
    Extracting  signatures/full_org/original_8_10.png             OK
    Extracting  signatures/full_org/original_8_11.png             OK
    Extracting  signatures/full_org/original_8_12.png             OK
    Extracting  signatures/full_org/original_8_13.png             OK
    Extracting  signatures/full_org/original_8_14.png             OK
    Extracting  signatures/full_org/original_8_15.png             OK
    Extracting  signatures/full_org/original_8_16.png             OK
    Extracting  signatures/full_org/original_8_17.png             OK
    Extracting  signatures/full_org/original_8_18.png             OK
    Extracting  signatures/full_org/original_8_19.png             OK
    Extracting  signatures/full_org/original_8_2.png              OK
    Extracting  signatures/full_org/original_8_20.png             OK
    Extracting  signatures/full_org/original_8_21.png             OK
    Extracting  signatures/full_org/original_8_22.png             OK
    Extracting  signatures/full_org/original_8_23.png             OK
    Extracting  signatures/full_org/original_8_24.png             OK
    Extracting  signatures/full_org/original_8_3.png              OK
    Extracting  signatures/full_org/original_8_4.png              OK
    Extracting  signatures/full_org/original_8_5.png              OK
    Extracting  signatures/full_org/original_8_6.png              OK
    Extracting  signatures/full_org/original_8_7.png              OK
    Extracting  signatures/full_org/original_8_8.png              OK
    Extracting  signatures/full_org/original_8_9.png              OK
    Extracting  signatures/full_org/original_9_1.png              OK
    Extracting  signatures/full_org/original_9_10.png             OK
    Extracting  signatures/full_org/original_9_11.png             OK
    Extracting  signatures/full_org/original_9_12.png             OK
    Extracting  signatures/full_org/original_9_13.png             OK
    Extracting  signatures/full_org/original_9_14.png             OK
    Extracting  signatures/full_org/original_9_15.png             OK
    Extracting  signatures/full_org/original_9_16.png             OK
    Extracting  signatures/full_org/original_9_17.png             OK
    Extracting  signatures/full_org/original_9_18.png             OK
    Extracting  signatures/full_org/original_9_19.png             OK
    Extracting  signatures/full_org/original_9_2.png              OK
    Extracting  signatures/full_org/original_9_20.png             OK
    Extracting  signatures/full_org/original_9_21.png             OK
    Extracting  signatures/full_org/original_9_22.png             OK
    Extracting  signatures/full_org/original_9_23.png             OK
    Extracting  signatures/full_org/original_9_24.png             OK
    Extracting  signatures/full_org/original_9_3.png              OK
    Extracting  signatures/full_org/original_9_4.png              OK
    Extracting  signatures/full_org/original_9_5.png              OK
    Extracting  signatures/full_org/original_9_6.png              OK
    Extracting  signatures/full_org/original_9_7.png              OK
    Extracting  signatures/full_org/original_9_8.png              OK
    Extracting  signatures/full_org/original_9_9.png              OK
    Extracting  signatures/full_org/Thumbs.db                     OK
    Extracting  signatures/Readme.txt                             OK
    All OK
```

```
def imshow(img,text=None,should_save=False):
    npimg = img.numpy()
    plt.axis("off")
```

```
    if text:
        plt.text(75, 8, text, style='italic',fontweight='bold',
            bbox={'facecolor':'white', 'alpha':0.8, 'pad':10})
    plt.imshow(np.transpose(npimg, (1, 2, 0)))
    plt.show()

def show_plot(iteration,loss):
    plt.plot(iteration,loss)
    plt.show()
```

Configuration Class

A simple class to manage configuration

```
class Config():
    training_dir = "training_data"
    testing_dir = "testing_data"
    train_batch_size = 64
    train_number_epochs = 100
    num_classes=5
```

Custom Dataset Class

This dataset generates a pair of images. 0 for geniune pair and 1 for imposter pair

```
class SiameseNetworkDataset(Dataset):

    def __init__(self,imageFolderDataset,transform=None,should_invert=True):
        self.imageFolderDataset = imageFolderDataset
        self.transform = transform
        self.should_invert = should_invert

    def __getitem__(self,index):
        img0_tuple = random.choice(self.imageFolderDataset.imgs)
        #print(img0_tuple)
        #we need to make sure approx 50% of images are in the same class
        should_get_same_class = random.randint(0,1)
        if should_get_same_class:
            while True:
                #keep looping till the same class image is found
                img1_tuple = random.choice(self.imageFolderDataset.imgs)
                if img0_tuple[1]==img1_tuple[1]:
                    break
        else:
            while True:
                #keep looping till a different class image is found

                img1_tuple = random.choice(self.imageFolderDataset.imgs)
                if img0_tuple[1] !=img1_tuple[1]:#code to get any 2 different pairs
                #if (img0_tuple[1]==0 and img1_tuple[1]==1) or (img0_tuple[1]==2 and img1_tuple[1]==3):
                    break

        print("imagepair",img0_tuple[1],':',img1_tuple[1])
        img0 = Image.open(img0_tuple[0])
        img1 = Image.open(img1_tuple[0])
        img0 = img0.convert("L")
        img1 = img1.convert("L")

        if self.should_invert:
            img0 = PIL.ImageOps.invert(img0)
            img1 = PIL.ImageOps.invert(img1)
```

```
        if self.transform is not None:
            img0 = self.transform(img0)
            img1 = self.transform(img1)

        return img0, img1 , torch.from_numpy(np.array([int(img1_tuple[1]!=img0_tuple[1])],dtype=np.float32))

    def __len__(self):
        return len(self.imageFolderDataset.imgs)
```

Using Image Folder Dataset

```
folder_dataset = dset.ImageFolder(root=Config.training_dir)
```

Double-click (or enter) to edit

```
siamese_dataset = SiameseNetworkDataset(imageFolderDataset=folder_dataset,
                                        transform=transforms.Compose([transforms.Resize((100,100)),
                                                                      transforms.ToTensor()
                                                                      ])
                                        ,should_invert=False)
```

Visualising some of the data

The top row and the bottom row of any column is one pair. The 0s and 1s correspond to the column of the image. 1 indiciates dissimilar, and 0 indicates similar.

```
vis_dataloader = DataLoader(siamese_dataset,
                        shuffle=True,
                        num_workers=8,
                        batch_size=8)
dataiter = iter(vis_dataloader)
example_batch = next(dataiter)
concatenated = torch.cat((example_batch[0],example_batch[1]),0)
imshow(torchvision.utils.make_grid(concatenated))
print(example_batch[2].numpy())
```

```
/usr/local/lib/python3.10/dist-packages/torch/utils/data/dataloader.py:560: UserWarning: This DataLoade
  warnings.warn(_create_warning_msg(
imagepairimagepairimagepair imagepairimagepair0imagepair imagepair     1020imagepair :2    2  2:: 3: :
 : : 2  021  1


0
0



imagepairimagepairimagepairimagepairimagepairimagepairimagepair imagepair   3       033101:2        ::3:::
   imagepair:022313
```

03imagepairimagepairimagepair
 imagepairimagepair   imagepair : 02210 imagepair   1:3 :: ::
 1   0 :imagepair 112
  :2

0 2
imagepair
1
  imagepairimagepairimagepairimagepair:
3   imagepair02331:   imagepair
0 :::: 3
 2:   3imagepair2 imagepair30 0

:

 31 : 0 :
imagepair1
imagepairimagepair 2 imagepair
imagepair0
imagepair   33imagepair0   ::1 : 1   imagepair   2 :0:31:1

   :3

 0:0imagepair
 1imagepairimagepair

 2imagepair   0imagepair02   :
3 : 2   :0:
imagepair   :1imagepair0imagepair11 imagepair

1:
  3
 0imagepair imagepair
: imagepairimagepair1 2   1 020:
2:imagepair   2 ::::: 0imagepair   2
 0 130

3imagepair 2

imagepair1
imagepair imagepair imagepair : 0imagepair: 3 0: 2 1
:210
: : :1 0
1imagepair

1

 3imagepairimagepair   imagepair: 00 imagepair 3 : :32:1
  :
0 3
2
imagepair
imagepair2imagepair   imagepair3:1   31: :
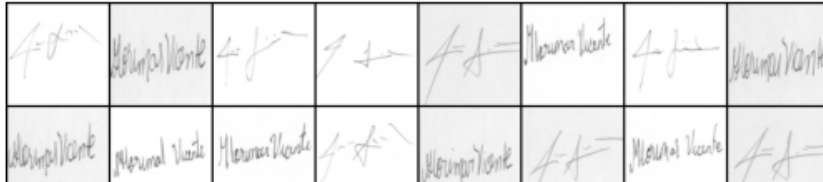 :3 33

```
imagepair
imagepair 0imagepair imagepair  2:1  1  :0
  ::  1imagepair10


3imagepairimagepair  imagepair :3 0  3 0: :
 : 0 2imagepair
2


2imagepairimagepairimagepair    :032    3:::
10


3
```


Neural Net Definition

We will use a standard convolutional neural network

```
[0.]
class SiameseNetwork(nn.Module):
    def __init__(self):
        super(SiameseNetwork, self).__init__()
        self.cnn1 = nn.Sequential(
            nn.ReflectionPad2d(1),
            nn.Conv2d(1, 4, kernel_size=3),
            nn.ReLU(inplace=True),
            nn.BatchNorm2d(4),

            nn.ReflectionPad2d(1),
            nn.Conv2d(4, 8, kernel_size=3),
            nn.ReLU(inplace=True),
            nn.BatchNorm2d(8),


            nn.ReflectionPad2d(1),
            nn.Conv2d(8, 8, kernel_size=3),
            nn.ReLU(inplace=True),
            nn.BatchNorm2d(8),


        )

        self.fc1 = nn.Sequential(
            nn.Linear(8*100*100, 500),
            nn.ReLU(inplace=True),

            nn.Linear(500, 500),
            nn.ReLU(inplace=True),

            nn.Linear(500, 5))

    def forward_once(self, x):
        output = self.cnn1(x)
        output = output.view(output.size()[0], -1)
        output = self.fc1(output)
        return output

    def forward(self, input1, input2):
        output1 = self.forward_once(input1)
```

```
        output2 = self.forward_once(input2)
        return output1, output2
```

Contrastive Loss

```python
class ContrastiveLoss(torch.nn.Module):
    """
    Contrastive loss function.
    Based on: http://yann.lecun.com/exdb/publis/pdf/hadsell-chopra-lecun-06.pdf
    """

    def __init__(self, margin=2.0):
        super(ContrastiveLoss, self).__init__()
        self.margin = margin

    def forward(self, output1, output2, label):
        euclidean_distance = F.pairwise_distance(output1, output2, keepdim = True)
        loss_contrastive = torch.mean((1-label) * torch.pow(euclidean_distance, 2) +
                                      (label) * torch.pow(torch.clamp(self.margin - euclidean_distance, min=0

        return loss_contrastive
```

Training Time!

```python
train_dataloader = DataLoader(siamese_dataset,
                        shuffle=True,
                        num_workers=8,
                        batch_size=Config.train_batch_size)
```

```python
device = torch.device("cuda:0" if torch.cuda.is_available() else "cpu")
print(device)
```

```
    cuda:0
```

```python
net = SiameseNetwork().cuda()
criterion = ContrastiveLoss()
optimizer = optim.Adam(net.parameters(),lr = 0.0005 )


counter = []
loss_history = []
iteration_number= 0
```

```python
for epoch in range(0,100):#Config.train_number_epochs):
    for i, data in enumerate(train_dataloader,0):
        img0, img1 , label = data
        img0, img1 , label = img0.cuda(), img1.cuda() , label.cuda()
        optimizer.zero_grad()
        output1,output2 = net(img0,img1)
        loss_contrastive = criterion(output1,output2,label)
        loss_contrastive.backward()
        optimizer.step()
        if i %10 == 0 :
            print("Epoch number {}\n Current loss {}\n".format(epoch,loss_contrastive.item()))
            iteration_number +=10
            counter.append(iteration_number)
            loss_history.append(loss_contrastive.item())
show_plot(counter,loss_history)
```

```
Streaming output truncated to the last 5000 lines.
: imagepair3
 imagepair3 : 2
 imagepair 32  : :2 3
imagepair
 3 : 2
imagepairimagepair 1  : 1
0 imagepair: 2 : 2 2

imagepairimagepair  3 :3 0
 imagepair:  3 : 03

imagepair imagepair 32 :  : 2
3imagepair
imagepair3 :  3
3imagepair : 0  2:
 imagepair 13
imagepair:  1
1 :imagepair  20
: imagepair 12
 imagepair:  02
: 3
imagepair 0 : 1
imagepair 0 : 1
imagepair 1 : 1
imagepair 1 : 1
imagepair 0 : 2
imagepair 3 : 3
imagepair 3 : 1
imagepair 1 : 0
imagepair 2 : 2
imagepair 0 : 2
imagepair 0 : 0
imagepair 3 : 3
imagepair 1 : 1
imagepair 3 : 3
imagepair 3 : 3
imagepair 2 : 0
imagepair 2 : 0
imagepair 2 : 0
imagepair 1 : 3
imagepair 0 : 0
imagepair 0 : 0
imagepair 3 : 1
imagepair 2 : 2
imagepair 0 : 1
imagepair 3 : 2
imagepair 1 : 0
Epoch number 49
 Current loss 0.04466002434492111

imagepairimagepair  23  ::  2
2
imagepairimagepair  13  ::  30

imagepairimagepair 2  2:  :0 2
imagepair
 imagepair2  3: :  32

imagepairimagepair  23  ::  3
0imagepair
 imagepair0  3: :1
 imagepair 33
imagepair  :3  : 3
imagepair0
 2 imagepair: 0
3 :
1imagepairimagepair  11 :  : 1
0
imagepairimagepair  13 :  3:
0imagepair 2
 :imagepair 2
```

```
2 :imagepair 2
0 : imagepair2
 imagepair1  :3  1: 0

imagepairimagepair  2 1 ::  1
0
imagepairimagepair  31  ::  32

imagepair imagepair 33  : : 32

imagepairimagepair  23  ::  20

imagepairimagepair  30  ::  00

imagepair imagepair0  1: :  1
0
imagepairimagepair  31  ::  32

imagepair imagepair0 2  ::  01

imagepairimagepair 0  0:  :0 2

imagepairimagepair  01  ::  00

imagepairimagepair  32  ::  33

imagepair 3 imagepair:  01
: imagepair1
1imagepair  :0  3:
 1imagepair
 imagepair0  0:  0:
 2imagepair
 imagepair3  1:  :1
 2imagepair
imagepair  12 :
1 imagepair :1 :
11
imagepairimagepair  2:  0
0 :imagepair  33
 imagepair: 3
1imagepair 2 :  1:
 imagepair 2 1: 2

imagepair 3 : 3
imagepair 3 : 0
imagepair 1 : 1
imagepair 3 : 3
imagepair 2 : 0
imagepair 2 : 2
imagepair 3 : 2
imagepair 3 : 3
imagepair 2 : 1
imagepair 0 : 1
imagepair 3 : 3
imagepair 1 : 1
imagepair 3 : 3
imagepair 2 : 3
imagepair 1 : 1
imagepair 3 : 3
imagepair 1 : 1
imagepair 0 : 0
imagepair 3 : 3
imagepair 1 : 1
imagepair 1 : 1
imagepair 1 : 1
imagepair 0 : 0
imagepair 1 : 1
imagepair 0 : 0
imagepair 3 : 2
imagepair 2 : 2
imagepair 0 : 0
imagepair 1 : 2
imagepair 0 : 0
```

```
imagepair 2 : 2
imagepair 1 : 3
Epoch number 50
 Current loss 0.03877564147114754

imagepairimagepair 1 :  02
 : imagepair1 2
 :imagepair  12
imagepair :  02
:imagepair  22
 imagepair:  22
 imagepair:  20
 :imagepair  03
 imagepair:  20
:imagepair  32
 imagepair:  31
 :imagepair  31
 : 3
imagepair imagepair1 2 :2
imagepair  :0  :2
imagepair 1
 0 : 0
imagepair 0imagepair :  2
3imagepair 2  : :3
imagepair  2
2imagepair :  22
 :imagepair  03
: imagepair 12
 :imagepair  02 :
0
imagepairimagepair 0 : 0
 1 : 0imagepair
imagepair  02 : 2
 :imagepair
 03  :imagepair 23
imagepair:  1 : 13

imagepair 1 : 2
imagepairimagepair 2  2 : 2:
imagepair  33
: 3
imagepair 1 : 0
imagepairimagepair 1 :  1
2 imagepair:  23
:imagepair 0 :  3
imagepair0
2imagepair  : 23
imagepair :  00
imagepair :3  0:
imagepair0   : 31

imagepairimagepair 3 : 3
imagepair  01 :  0
: imagepair 2 :3
 1imagepair
0 imagepair : 1
1imagepair  1 : 0
: imagepair 02
 imagepair:  2
1 imagepair: 1 0 : 2

imagepairimagepair  32  ::  23

imagepair 2 : 2
imagepair 1imagepair : 1
 imagepair0  :1:   0
1
imagepair imagepair0 : 0
0 imagepair :0 : 0
0
imagepairimagepair  20  ::  02
```

```
imagepair 1 : 0
imagepair 2 : 2
imagepair 1 : 0
imagepair 1 : 0
imagepair 0 : 2
imagepair 2 : 2
imagepair 1 : 1
imagepair 3 : 1
imagepair 2 : 1
imagepair 3 : 3
imagepair 2 : 1
imagepair 3 : 3
imagepair 2 : 1
imagepair 2 : 1
imagepair 3 : 3
imagepair 3 : 3
imagepair 2 : 2
imagepair 3 :2
imagepair 1 : 3
imagepair 0 : 3
imagepair 0 : 2
imagepair 3 : 3
imagepair 0 : 0
imagepair 1 : 1
imagepair 2 : 1
imagepair 2 : 2
imagepair 3 : 3
imagepair 0 : 0
imagepair 2 : 2
Epoch number 51
 Current loss 0.039546363055706024

imagepairimagepair  2 2:  :2
2
imagepair 2imagepair  1:  2:
3
imagepair 1imagepair  :1  1:
 imagepair 0
2 :imagepair 0 0
 imagepair:  20
: imagepair 02
 : imagepair2
 imagepair0  1: : 3
 1
imagepair imagepair0 :  01
 : 0imagepair
 1imagepair  :0 : 1
 2imagepair
0imagepair :   21
imagepair:  0 0:
 imagepair1
2 imagepair:  2 :1
3
imagepairimagepair  03  ::  00

imagepairimagepair  10  ::  31

imagepairimagepair  20  ::  23

imagepair imagepair 22  ::  03

imagepairimagepair  01  : :2
imagepair0
1 : imagepair1
0 imagepair 2: : 2
 imagepair 0
0 imagepair : 30 :
 3
imagepairimagepair  20  ::  02

imagepair imagepair1  3  :3: 1

imagepairimagepair  02 : : 0
```

```
1
imagepair imagepair3 :  1 0:
0
imagepair imagepair 31 : :  31

imagepair 0imagepair  :0  2:
 3imagepair
 3imagepair  2: :  32

imagepairimagepair 3  3:  :1
0
imagepair imagepair0 2  :: 3 2

imagepairimagepair 3 3  :: 0
 imagepair3 0 :
 2
imagepairimagepair  22 :  : 2
1imagepair
imagepair 0 :  1
0imagepair  : 00
: 1
imagepair imagepair0 : 0 2 :
 3
imagepair imagepair1 : 1
 2 : 3
imagepair 2 : 0
imagepair 3 : 3
imagepair 0 : 0
imagepair 0 : 3
imagepair 1 : 2
imagepair 3 : 3
imagepair 2 : 2
imagepair 1 : 0
imagepair 0 : 3
imagepair 3 : 1
imagepair 1 : 2
imagepair 0 : 0
imagepair 0 : 2
imagepair 3 : 2
imagepair 1 : 1
imagepair 2 : 2
imagepair 3 : 0
imagepair 1 : 1
imagepair 0 : 2
imagepair 2 : 3
imagepair 3 : 0
imagepair 1 : 1
imagepair 3 : 2
imagepair 0 : 0
imagepair 0 : 0
imagepair 3 : 2
imagepair 2 : 2
imagepair 2 : 1
imagepair 2 : 0
imagepair 2 : 0
Epoch number 52
 Current loss 0.017853356897830963

imagepair imagepair 2 2 ::  2
1
imagepair 2imagepair  : 2
2 imagepair: 1 :  10

imagepairimagepair  00  : 3
: imagepair2
1imagepair  :1  : 23
imagepair
 imagepair 1 1:  2:
2imagepair
3: imagepair 3
3 : imagepair2
 2 imagepair :3 1
: 0
```

```
. 0
imagepairimagepair  30  ::  2
1
imagepair imagepair 12  ::  12

imagepairimagepair  10 :  2
: imagepair 1 :3
imagepair  03
 :imagepair 30
imagepair:  10
:imagepair  0 2
: 2
imagepairimagepair 1  0 : :3
 1
imagepairimagepair  22 :  3
: imagepair 20
 imagepair:  10
: imagepair3
imagepair  13  ::  23

imagepairimagepair  1 : 3 :3
3
imagepairimagepair 1  : 2
1imagepair 2  :: 1
2
imagepairimagepair  12 :  0
imagepair:  3
3 :imagepair 3 3
 : 1imagepair
 3 : imagepair2
imagepair  3 :2  : 21

imagepairimagepair 2 :  3 : 2
2imagepair 0
 imagepair: 2
imagepair  33 :  :
3 1imagepair 1 :
1
 imagepair2 : 2
imagepairimagepair  0: 3  : 3
0
imagepairimagepair  3 1:  2
:imagepair  31
 : 1
imagepair 0 : 0
imagepair 1 : 0imagepair
 3imagepair : 0
3 : 3
imagepairimagepair  3: 0
 0imagepair :
 0 imagepair3 :  3
0imagepair  1 :: 1
 2
imagepair 1 : 1
imagepair 3 : 2
imagepair 0 : 0
imagepair 0 : 0
imagepair 2 : 2
imagepair 1 : 3
imagepair 1 : 0
imagepair 2 : 1
imagepair 2 : 1
imagepair 0 : 0
imagepair 0 : 0
imagepair 1 : 2
imagepair 1 : 1
imagepair 0 : 0
imagepair 0 : 3
imagepair 2 : 3
imagepair 1 : 3
imagepair 2 : 2
imagepair 0 : 0
imagepair 2 : 2
```

```
imagepair 2 : 0
imagepair 1 : 3
imagepair 2 : 0
imagepair 0 : 1
imagepair 2 : 1
imagepair 0 : 0
imagepair 1 : 1
imagepair 2 : 1
imagepair 1 : 2
Epoch number 53
 Current loss 0.028132326900959015


imagepair imagepair 30  :: 2
0
imagepair imagepair0  2:  :2
2imagepair
 imagepair0  0:  :0
3imagepair
 imagepair3  2:  :3
1imagepair
 imagepair 20 :   3
imagepair:   20
: 2imagepair
 3 : 2imagepair
 imagepair 12 :   2
: imagepair0 1
:imagepair   33
 imagepair 1: :   2
3imagepair
 imagepair 32  ::   32


imagepair imagepair1  0:  :1
0
imagepairimagepair 0 2 : 2
 :imagepair   0 : 1
1imagepair
 imagepair3  2 ::   3
imagepair2 3
imagepair :   10
: imagepair0
 imagepair 3 0: 0
 imagepair: 0  :0
 0imagepair
 imagepair 02 :  :2
imagepair 0
 imagepair0 : 0
imagepair2
: 0 imagepair2 :
2imagepair  03  ::   13


imagepairimagepair  30  ::   03


imagepairimagepair  23  ::   33


imagepairimagepair  20  :: 0
 imagepair 1 : 2
0
 imagepairimagepair  1 :11
 : 3
imagepairimagepair  3 1 ::   01


imagepairimagepair  20  ::   2
0
imagepair imagepair 20  : :0
1
imagepair imagepair 00 :   :0
3
imagepairimagepair  01  ::   01


imagepairimagepair 2  :1  0:
 imagepair 31
 imagepair:  31
: imagepair 10
```

```
 :imagepair  23
 imagepair:  33
 imagepair:  00 :
 imagepair0
3 imagepair:  23
: 2
imagepair 0 : 1
imagepair 3 : 3
imagepair 1 : 1
imagepair 2 : 3
imagepair 1 : 1
imagepair 2 : 2
imagepair 2 : 2
imagepair 1 : 1
imagepair 1 : 3
imagepair 0 : 0
imagepair 2 : 3
imagepair 1 : 3
imagepair 1 : 0
imagepair 1 : 1
imagepair 2 : 2
imagepair 0 : 0
imagepair 0 : 0
imagepair 2 : 2
imagepair 1 : 2
imagepair 2 : 2
imagepair 3 : 0
imagepair 2 : 2
imagepair 2 : 2
imagepair 0 : 2
imagepair 3 : 1
imagepair 1 : 2
imagepair 1 : 0
imagepair 3 : 0
imagepair 0 : 0
Epoch number 54
 Current loss 0.034525610506534576

imagepair imagepair 1 1:  :1
 1
imagepair imagepair 1 2::  1 1

imagepairimagepair  00  :: 2
 3
imagepair imagepair3  1:  :3
3imagepair
 3imagepair  :1  2:
 0imagepair
 imagepair3  :2  :2
imagepair2 3
 : imagepair3 3
imagepair  1: : 3
3imagepair
1 :imagepair 0 2
 imagepair 3:  :0
1imagepair
 2imagepair  :3  0:
 0imagepair
 3imagepair  3:  :0
2imagepair
 imagepair0  1:  :0
0imagepair
 imagepair0  3:  :0
3
 imagepairimagepair  02 :  0
: imagepair0
1imagepair :  1 :3
 1
imagepairimagepair 0  3:  3:
 imagepair 31
 imagepair:  21
: imagepair3
```

```
1imagepair  :1  3:
 0imagepair
 1imagepair  :2  0:
 imagepair2
 2imagepair  :0  2:
 2imagepair
 0imagepair  :0  1:
 imagepair2
 1imagepair  :3  :2
 imagepair2
 imagepair1  1:  1
: 2
imagepair imagepair3 1 :  0
: imagepair 33
imagepair :  3
imagepair0 3 :  3
imagepair 3:  0
imagepair: 2
imagepair 0 :  0
0imagepair  0:  :1
 0imagepair
1imagepair  1 :
0: 0imagepair
1imagepair  : 31
 imagepair:  1 : 03

imagepairimagepair  10  : : 20

imagepairimagepair  2 :3 : 1 0

imagepair imagepair 11  :: 0
 1
imagepair 3 : 3
imagepair 1 : 1
imagepair 3 : 0
imagepair 3 : 1
imagepair 0 : 3
imagepair 1 : 1
imagepair 1 : 3
imagepair 0 : 3
imagepair 2 : 1
imagepair 0 : 0
imagepair 1 : 3
imagepair 1 : 1
imagepair 0 : 3
imagepair 2 : 2
imagepair 2 : 0
imagepair 0 : 3
imagepair 0 : 2
imagepair 0 : 0
imagepair 3 : 3
imagepair 2 : 2
imagepair 0 : 0
imagepair 2 : 2
imagepair 3 : 3
imagepair 0 : 1
imagepair 3 : 3
imagepair 3 : 3
imagepair 1 : 0
imagepair 2 : 2
imagepair 0 : 0
imagepair 2 : 2
Epoch number 55
 Current loss 0.034989528357982635

imagepairimagepair  03 :  : 13

imagepairimagepair 1  :1  : 33

imagepairimagepair  23 :  :2
0
imagepair imagepair3 2  :: 2
2
```

```
imagepair imagepair 21  ::  22

imagepairimagepair 0  : 10
: imagepair 2 : 2
1imagepair
 imagepair2 : 3  2
: 3
imagepair imagepair0  : 32
 : imagepair2
2 imagepair: 0 2
 :imagepair  2
3imagepair :  0
2imagepair  0 :: 0
 imagepair1 0
 :
0imagepairimagepair 2 : 3
 imagepair1 : 2  :1
0imagepair
imagepair1  2:  : 21

imagepairimagepair  02  ::  22

imagepair imagepair1  1:  :1
1imagepair
 1imagepair 0  :3 :
imagepair 0
1imagepair 2 : 2
 :imagepair 3
 0imagepair  1 : :0
 2imagepair
 imagepair2  3 : : 1
2imagepair
imagepair  1 : 02
imagepair :  0
3imagepair  3: 3
 imagepair:  2 : 2
1imagepair
 1 : 1
imagepair 1imagepair  1 :: 0
 0imagepair
 imagepair0  :0 : 1
 1
imagepair 1 imagepair  :2
1 imagepair:  13
 :imagepair  10
imagepair:  0
2imagepair  : 02
:imagepair 1
 3 : 3
imagepairimagepair  1 : 1
3imagepair 0 :  3: 3
imagepair
0:imagepair  3  0:
 imagepair3
0imagepair  :0  :3
3imagepair
 imagepair1  0: :  00

imagepair 2 : 2
imagepair 0 : 1
imagepair 3 : 0
imagepair 2 : 2
imagepair 2 : 2
imagepair 2 : 0
imagepair 1 : 1
imagepair 2 : 2
imagepair 2 : 2
imagepair 1 : 1
imagepair 2 : 0
imagepair 3 : 0
imagepair 0 : 3
imagepair 2 : 1
imagepair 3 : 0
```

```
imagepair 3 : 0
imagepair 1 : 1
imagepair 3 : 3
imagepair 0 : 3
imagepair 2 : 2
imagepair 2 : 1
imagepair 1 : 3
imagepair 3 : 1
imagepair 2 : 1
imagepair 0 : 0
imagepair 1 : 1
imagepair 1 : 1
imagepair 2 : 0
imagepair 1 : 1
imagepair 0 : 0
imagepair 2 : 2
Epoch number 56
 Current loss 0.027356432750821114

imagepair 0imagepair  : 01
 : imagepair 11
 : imagepair3 2
  :2
imagepairimagepair  0 :1
2imagepair : 2
 0imagepair : 1 : 0
 imagepair 21 : 2
imagepair 0 : 0

imagepairimagepair  11  ::  21

imagepairimagepair  23  ::  32

imagepairimagepair  13  ::  23

imagepair 0imagepair 0 : 3
 :imagepair  3 3:
0
imagepairimagepair 32  ::  2
0
imagepair imagepair2  :0 3
imagepair:  1
0 imagepair:  03
:imagepair  33
 : 3imagepair
 imagepair3  2:  :3
2imagepair
imagepair1  0 :: 0
imagepair1
 imagepair2  : 30 :
 3
imagepairimagepair  23 :  0: 2

imagepairimagepair  00  :: 3
 imagepair0
 1 :imagepair 1
 imagepair2 : 2
 0 : imagepair 10 :
1imagepair
 imagepair1 0  :: 1
1imagepair 0 : 3

imagepairimagepair 0 : 0
 2 imagepair 3:  :2
0imagepair
imagepair  01  ::  22

imagepair 0imagepair  2:  : 31

imagepair imagepair0  1:  :3
1imagepair
 3imagepair  3:  :3
 3imagepair
```

```
 3imagepair  2: :  33
imagepair
 imagepair1  : 1 : 13

imagepairimagepair 0  0 :: 0
 0
imagepair 1 : 1
imagepair 3 : 3
imagepair 3 : 2
imagepair 0 : 0
imagepair 1 : 3
imagepair 3 : 3
imagepair 1 : 1
imagepair 1 : 1
imagepair 0 : 1
imagepair 3 : 2
imagepair 1 : 3
imagepair 2 : 2
imagepair 0 : 2
imagepair 0 : 0
imagepair 2 : 2
imagepair 3 : 0
imagepair 2 : 1
imagepair 1 : 1
imagepair 0 : 0
imagepair 2 : 3
imagepair 2 : 2
imagepair 3 : 0
imagepair 3 : 3
imagepair 2 : 1
imagepair 2 : 2
imagepair 0 : 0
imagepair 0 : 2
imagepair 1 : 3
imagepair 1 : 2
imagepair 2 : 0
imagepair 2 : 0
imagepair 3 : 3
imagepair 0 : 0
imagepair 1 : 0
imagepair 3 : 3
imagepair 3 : 0
Epoch number 57
 Current loss 0.03475639969110489

imagepairimagepair  1 : 13
 : 3imagepair
 1imagepair :   21
:imagepair 2
 imagepair0 : 1
 imagepair0  3: 0
 :imagepair 2
 imagepair 03 : 3
:
0imagepair 3 : 3
imagepair 3 :imagepair 2
 2imagepair 2 : 1
 :imagepair 1  : 1
1
imagepair imagepair3 : 3 : 3
 imagepair3
imagepair 3 0 : 1
 imagepair:  1
1 imagepair:  33 : 2

imagepairimagepair 1 3
 : 1imagepair  3: :  1
imagepair0
imagepair  2 :
02imagepair  3: 2 : 1

imagepairimagepair  10  ::  10
```

```
imagepair  0:imagepair 3
 imagepair  23 : :3 0

imagepair imagepair0  :0   3:
 imagepair0
 2 :imagepair 0
 13
 : imagepair 0 : 0
imagepair 3imagepair: :3  3
 imagepair3
0imagepair :  00
:imagepair 0
1 imagepair:  01 : 1

imagepair 0imagepair  2:  :0
 1imagepair
 3imagepair  :1  :2
 2
imagepair imagepair3  :2 3
: 2imagepair
 imagepair0 1 : : 0
3imagepair
imagepair 3  : 23
:imagepair  00
: 3
imagepair 1 : 1
imagepair imagepair0 1  : 3:
3
imagepairimagepair  32  ::  33

imagepairimagepair  1 : 32
 imagepair:  00
: imagepair 1
0 imagepair :0 0 :
imagepair0
3 imagepair :2 3
:imagepair  2
2 imagepair: 0  2
: 0
imagepair 2 : 2
imagepair 1 : 1
imagepair 3 : 1
imagepair 0 : 3
imagepair 0 : 0
imagepair 1 : 1
imagepair 1 : 1
imagepair 3 : 3
imagepair 0 : 0
imagepair 2 : 0
imagepair 1 : 1
imagepair 2 : 0
imagepair 0 : 0
imagepair 1 : 3
imagepair 3 : 1
imagepair 0 : 0
imagepair 3 : 2
imagepair 0 : 2
imagepair 1 : 1
imagepair 2 : 2
imagepair 0 : 0
imagepair 3 : 0
imagepair 3 :
2imagepair 2 : 2
imagepair 1 : 3
imagepair 0 : 3
imagepair 3 : 1
imagepair 1 : 1
imagepair 3 : 1
Epoch number 58
 Current loss 0.021921537816524506

 imagepairimagepair 1 :  1
```

```
1imagepair : 1
 2imagepair  : 12
: imagepair0
1 : 3
imagepair 2 imagepair: 11 :
 2imagepair
imagepair  11  ::   11

imagepairimagepair 3 : 1
3 imagepair :1 3
:imagepair 0
 2imagepair 3 : 2
:
1imagepairimagepair  11  ::   13

imagepairimagepair 3  :2 0
:imagepair 3
 2 :imagepair  2
1imagepair :   2
1 imagepair:  2 :1
2
imagepairimagepair 0 0  : 2
:imagepair  03 : 2

imagepair 1:   1
imagepairimagepair 1 0 : 0
:0 imagepair
3imagepair  : 31
imagepair :   2
imagepair0  : 0
3 imagepair : 3
3 :imagepair 1
 1imagepair  :1  : 30

imagepairimagepair  3 : 22 : 0

imagepair imagepair0  :
02imagepair 2  ::   22

imagepairimagepair  22 :   :3 1

imagepair imagepair0 0  : :1 2

imagepairimagepair 0  :3 3
: imagepair 20
 : imagepair 03 :
imagepair  31
 : 3
imagepair 1 imagepair :2 :   12

imagepair 1 imagepair:   21
:imagepair  3 : 32

imagepairimagepair  3 1 : : 10

imagepairimagepair 1 2  :: 1
 3
imagepairimagepair  32 ::   02

imagepairimagepair  31 ::   01

imagepair imagepair 21 :  0:
 3
imagepair imagepair0  3:  :3
3
imagepair 3 : 3
imagepair 3 : 3
imagepair 1 : 3
imagepair 2 : 0
imagepair 1 : 2
imagepair 0 : 3
imagepair 1 : 1
imagepair 2 : 2
```

```
imagepair 3 : 1
imagepair 0 : 0
imagepair 0 : 0
imagepair 3 : 3
imagepair 1 : 1
imagepair 2 : 2
imagepair 1 : 1
imagepair 0 : 2
imagepair 2 : 2
imagepair 0 : 0
imagepair 3 : 1
imagepair 0 : 0
imagepair 0 : 0
imagepair 3 : 0
imagepair 2 : 1
imagepair 1 : 0
imagepair 3 : 3
imagepair 0 : 1
imagepair 3 : 2
imagepair 2 : 0
imagepair 1 : 3
imagepair 3 : 0
Epoch number 59
 Current loss 0.02831638790667057

imagepair imagepair2  : 3
0 :imagepair  0
0 :imagepair  12 :
0
imagepair imagepair0 : 0
imagepair  21  :: 2
 imagepair0 2
:imagepair  11 : 1

imagepairimagepair  12  : :1
1imagepair
 imagepair3 : 3
 imagepair3 : 3
2imagepair  :3 : 3 2

imagepair imagepair3  0 :: 2
2imagepair
2 imagepair:  21
: imagepair2 0
 : 1imagepair
2 imagepair: 3  : 3
3
imagepair imagepair 11  ::  11

imagepair imagepair2  : 3
0imagepair  0:  :2
 imagepair1 2
 : 2
imagepair imagepair 1 0:  1:
 0imagepair
 1imagepair  0: :
03
imagepair imagepair 13 :  3
: imagepair1
 imagepair2 : 2  2: 2

imagepairimagepair  0 : 1 0: 1

imagepairimagepair 1  : 31 :3

imagepair imagepair0 3  : : 02

imagepair 3 : 3
imagepairimagepair 0 :  1
1imagepair :  1
2 : 3
imagepairimagepair  13  ::  23
```

```
imagepairimagepair 1 1  : :3 1

imagepair imagepair0  0 :  :00

imagepairimagepair 0  3:  0
: 3imagepair
 2imagepair 3 : 1
: 3imagepair
imagepair 1 :  2
2 imagepair:  10
:imagepair 1
2imagepair  2 : :1
imagepair 0
 imagepair0  3:  1:2

imagepair imagepair 03  ::  22

imagepairimagepair  03  :: 2
2imagepair
0 : 3
imagepair 3 : 3
imagepair 0 : 0
imagepair 3 : 3
imagepair 0 : 0
imagepair 3 : 0
imagepair 3 : 0
imagepair 3 : 3
imagepair 2 : 0
imagepair 0 : 0
imagepair 2 : 2
imagepair 3 : 3
imagepair 3 : 2
imagepair 1 : 1
imagepair 3 : 2
imagepair 1 : 3
imagepair 2 : 0
imagepair 3 : 1
imagepair 3 : 0
imagepair 2 : 3
imagepair 0 : 1
imagepair 1 : 1
imagepair 3 : 2
imagepair 1 : 0
imagepair 2 : 0
imagepair 0 : 3
imagepair 1 : 1
imagepair 1 : 3
imagepair 0 : 0
Epoch number 60
 Current loss 0.019647199660539627

imagepairimagepair 0 : 0 :  0
3
imagepair 2imagepair 1  : 3:
 imagepair 1
2 :imagepair 3 3
 :imagepair  10 : 1

imagepair 0 : 0
imagepair imagepair 10  : 2
:imagepair 1
 imagepair3  :3
 imagepair2 1 : 1
 imagepair:  12
 :imagepair  00
: imagepair2
1 imagepair :0  1:
 1imagepair
 2imagepair  2:  2
: imagepair2 0
 :imagepair 2 3
 : 0imagepair
```

```
 3imagepair  :1 2
: imagepair1
0imagepair  0:  0:
 0imagepair 0
:imagepair  02
imagepair: 1  0
: 1imagepair
1 : imagepair1
3 imagepair2 :  0: 3

imagepair imagepair3 :  3
imagepair0  2 :: 1
0imagepair
 imagepair3  :0  1
: imagepair2
2 : 3
imagepair
 1 : 2imagepairimagepair  0 1 :: 1
 0
imagepair imagepair2 2 : : 1
imagepair0
2 : 0
imagepairimagepair 3  3: : 3 3

imagepair imagepair0  :1  0:
imagepair 3
2imagepair  3 : :3
 3imagepair
 imagepair2  2 : : 12

imagepairimagepair  21  :: 3
1
imagepair 1imagepair  :1 1
: 1imagepair
2 : 2
imagepairimagepair  11  :
3  :imagepair
1 3imagepair  :1  3:
1imagepair
 imagepair0 :  2
0 imagepair: 0 :
0 imagepair0 0
 : 0
imagepairimagepair  3:  0
1 imagepair 0 :
1:imagepair 1
 1 : 0
imagepair 2 : 2
imagepair 2 : 1
imagepair 0 : 0
imagepair 1 : 1
imagepair 3 : 1
imagepair 2 : 2
imagepair 1 : 1
imagepair 2 : 1
imagepair 2 : 2
imagepair 3 : 3
imagepair 3 : 3
imagepair 1 : 0
imagepair 3 : 1
imagepair 0 : 0
imagepair 1 : 1
imagepair 2 : 3
imagepair 3 : 0
imagepair 3 : 1
imagepair 1 : 1
imagepair 0 : 1
imagepair 2 : 0
imagepair 3 : 3
imagepair 0 : 0
imagepair 1 : 0
imagepair 2 : 3
imagepair 1 : 0
```

```
imagepair 1 : 0
imagepair 3 : 1
imagepair 2 : 2
Epoch number 61
 Current loss 0.020704425871372223

imagepairimagepair 0  : 0
2 imagepair:  1
3 imagepair: 3  : 3
3
imagepair 3 : imagepair 1 : 3
3
imagepairimagepair 2  : 12 : 0

imagepairimagepair  2 : 2
0 imagepair : 3 :0 3

imagepairimagepair  03  ::  03

imagepairimagepair  0 : 31
:imagepair  31
: 3
imagepairimagepair 2  : 2
0 imagepair:  01
 : 3
imagepair imagepair 0 : 33
imagepair : 0  3: 0

imagepair imagepair0 1 : 0 :
2
imagepair imagepair 03 : :  2
2
imagepairimagepair  11  ::  20

imagepairimagepair  22 :  : 00

imagepairimagepair 3  : 3
3 :imagepair  33
imagepair  :0 3
 imagepair: 3 : 0
 imagepair2
 2imagepair  :2  3:
imagepair 0 1 :
 1
imagepairimagepair  12 :  0:
 0imagepair
 3imagepair  : 30
 :imagepair  10
:imagepair  21
 :imagepair 1
1 imagepair: 3 0
:imagepair 2
1 imagepair : 13
:imagepair 0
3 imagepair:  0
3 imagepair:  13
 : imagepair 1
2 : imagepair3
imagepair  03  ::  13

imagepair 1imagepair  :0 1
: imagepair 3
2 imagepair 1 :1
: imagepair2 3
 imagepair:  01

 31
1 imagepair::imagepair  2 : 1
imagepair  1 :1
imagepair 0 : 0
imagepair 3 : 0
imagepair 1 : 2
imagepair 3 : 3
```

```
imagepair 3 : 1
imagepair 2 : 3
imagepair 1 : 3
imagepair 1 : 1
imagepair 3 : 2
imagepair 1 : 2
imagepair 3 : 3
imagepair 0 : 1
imagepair 2 : 0
imagepair 3 : 2
imagepair 3 : 2
imagepair 1 : 1
imagepair 0 : 0
imagepair 2 : 3
imagepair 0 : 3
imagepair 0 : 1
imagepair 2 : 2
imagepair 2 : 2
imagepair 1 : 1
imagepair 1 : 3
imagepair 0 : 3
imagepair 1 : 0
imagepair 0 : 0
imagepair 0 : 0
imagepair 0 : 2
imagepair 3 : 1
imagepair 3 : 3
imagepair 0 : 0
imagepair 3 : 0
Epoch number 62
 Current loss 0.02146320231258869

imagepairimagepair 1  :0  :3
 3
imagepair 3 : imagepair 12
imagepair 2  : :0
0
imagepair imagepair0  :0  0:
0
imagepairimagepair 3 3 :  0:
 imagepair 3
3 imagepair 2: :  23

imagepairimagepair  12  ::  22

imagepair imagepair 13  ::  13

imagepairimagepair  22 :  :2
 1
imagepair 2imagepair  : 1 1
: imagepair1
3 imagepair:  11
: imagepair0
0 imagepair:  3 2:
 2imagepair
 imagepair2  1:  1:
 imagepair1
 imagepair3  :2  3:
 imagepair 02
 : imagepair2
imagepair1  : 30
:imagepair  0 3:
 imagepair2
2imagepair  :2  :1 1

imagepairimagepair 0  1:  1
: imagepair2 2
imagepair  0 : :0 0

imagepairimagepair  30  ::  31

imagepair 1imagepair  0: : 1 1
```

```
imagepairimagepair  11  ::  10

imagepairimagepair 0  0 : :1
imagepair2
 imagepair0  : 10
: 1imagepair
0 imagepair:  00
 :imagepair  10
 :imagepair 0 3
 :imagepair 3
imagepair1  :3  2:
 2imagepair
 imagepair2  :2  1:
 imagepair 2
0 :imagepair  11
 : 3
imagepair 2imagepair  :3 2 :
 imagepair1
2imagepair  :0 2
 imagepair:  13
 : 3
imagepairimagepair  21  : :2 2

imagepairimagepair  2 :0  2:
imagepair  32
 : 3
imagepair 2 : 0
imagepair 0 : 0
imagepair 3 : 0
imagepair 2 : 2
imagepair 0 : 0
imagepair 0 : 0
imagepair 3 : 3
imagepair 3 : 3
imagepair 2 : 0
imagepair 3 : 2
imagepair 1 : 2
imagepair 3 : 3
imagepair 0 : 0
imagepair 0 : 0
imagepair 0 : 0
imagepair 1 : 3
imagepair 3 : 1
imagepair 0 : 0
imagepair 3 : 3
imagepair 1 : 1
imagepair 1 : 1
imagepair 2 : 2
imagepair 3 : 2
imagepair 2 : 1
imagepair 1 : 2
imagepair 0 : 0
imagepair 0 : 0
imagepair 0 : 0
imagepair 1 : 1
Epoch number 63
 Current loss 0.035200029611587524

imagepairimagepair  13  : : 02

imagepair 3 imagepair : 03 :
3imagepair
 imagepair2  :2  0:
 1
imagepairimagepair 2 0 :  : 20

imagepair imagepair 00 : 0
 :imagepair  10 :
 1imagepair
0 : 0
imagepairimagepair 0  :2  0:
1
```

```
imagepairimagepair 2 :
 2 imagepair3  0: 0
imagepair:  10
  :1
imagepair imagepair1 :0
 2 : 2
imagepairimagepair  2 : 2
2imagepair 0 : 1
 :imagepair  22
 :imagepair  30
 imagepair:  20
:imagepair  23
 :imagepair 3
 imagepair1  :1 3 :
 imagepair1
3 imagepair: 3
1 :  imagepair 1
1 :imagepair  1 : 2
1imagepair
3imagepair : 3
 imagepair 10  :: 0
 imagepair 20 :
2
imagepairimagepair  1 : 1
0 :imagepair 3
 imagepair1 :  0
2imagepair : 0
 imagepair 2 0: 3
: imagepair0
3imagepair  2 : :1
 imagepair3
 imagepair31   : 1
: 3imagepair
 2 imagepair: 2  : 2
2imagepair
imagepair 1 3  : : 21

imagepairimagepair  21 : 3
:imagepair  3 1:
 3
imagepair 0imagepair  :0 0
: imagepair3
1imagepair  2:  0:
 0imagepair
 2 imagepair:  22
: 2imagepair
imagepair  20 : 3
 imagepair: 2  :1 2

imagepair 2 : 0
imagepair 0 : 0
imagepair 1 : 3
imagepair 0 : 1
imagepair 1 : 1
imagepair 2 : 3
imagepair 1 : 1
imagepair 2 : 0
imagepair 1 : 1
imagepair 0 : 0
imagepair 0 : 0
imagepair 0 : 0
imagepair 3 : 1
imagepair 2 : 0
imagepair 3 : 3
imagepair 2 : 2
imagepair 2 : 3
imagepair 3 : 3
imagepair 0 : 3
imagepair 1 : 1
imagepair 0 : 0
imagepair 2 : 2
imagepair 1 : 1
imagepair 0 : 2
```

```
imagepair 3 : 1
imagepair 3 : 3
imagepair 2 : 2
imagepair 0 : 1
imagepair 1 : 1
imagepair 1 : 1
imagepair 3 : 3
imagepair 2 : 3
imagepair 0 : 0
Epoch number 64
 Current loss 0.030950438231229782


imagepairimagepair  1 3:  : 20


imagepairimagepair  23 : 3
imagepair :1
imagepair   12:
2imagepair 1 : :  11


imagepair imagepair 1 : 30
:imagepair 2  : 13


imagepair3imagepair  : 3
imagepair 2 : 2
 imagepair 3 3: : 2
 imagepair 1 1:
1
imagepair imagepair2 :  2
0imagepair
: 0 imagepair2 :  2
2 imagepair 1  :3
: imagepair2 1 : 1


imagepairimagepair  3 : 33
imagepair  :1 : 3
 imagepair0
0 imagepair 3 : 0
imagepair:  2
0imagepair :  03
imagepair :  23
 imagepair: 2  : 0
2imagepair
 1imagepair  : 1 : 11


imagepairimagepair 1 0  : : 20


imagepairimagepair 3 2 : :  0
2
imagepair 3 imagepair:  3
2imagepair  :1  0:
 1imagepair
 1imagepair  :3  3:
3imagepair
 imagepair1  0 : 2:
2
imagepair imagepair 31 :  :3
1
imagepairimagepair  33 : : 2
3imagepair
 imagepair0  : 02
 : 0
imagepairimagepair  00 : 2
 imagepair: 1  :0 0


imagepairimagepair  3 2:  1:
0
imagepair 1 :imagepair  2
0 :imagepair  31
 imagepair: 2
 imagepair0  3:  :1
3imagepair
0 :imagepair 2 0
```

```
:imagepair 3 : 3 2

imagepairimagepair  0 1 : 2:
1imagepair
 1 :imagepair  11 :
 1
imagepairimagepair 2 0 : : 2
 1imagepair
 0 : 0
imagepair 3 : 3
imagepair 2 : 1
imagepair 2 : 0
imagepair 3 : 3
imagepair 3 : 0
imagepair 0 : 0
imagepair 2 : 2
imagepair 3 : 3
imagepair 3 : 3
imagepair 0 : 0
imagepair 2 : 0
imagepair 1 : 3
imagepair 3 : 3
imagepair 2 : 0
imagepair 1 : 2
imagepair 0 : 3
imagepair 3 : 2
imagepair 0 : 0
imagepair 0 : 0
imagepair 2 : 3
imagepair 2 : 0
imagepair 1 : 0
imagepair 3 : 0
imagepair 0 : 2
imagepair 3 : 0
imagepair 1 : 1
imagepair 3 : 2
Epoch number 65
 Current loss 0.02896345779299736

imagepair 3 : 3
imagepair imagepair1  0:  :3 0

imagepairimagepair  11  ::   1
1
imagepair 1 : 0
imagepair imagepair3 2  : 2
: 3imagepair
 1 imagepair:  21
:imagepair  33
: 2imagepair
imagepair 1 3  ::   10

imagepair imagepair3  2:  :0
1
imagepairimagepair  23  ::   33

imagepairimagepair  33  ::   10

imagepairimagepair  3 3:  :1
2imagepair
 imagepair 30  : :3
3imagepair
 imagepair 31  ::   11

imagepairimagepair 2  3: :  23

imagepairimagepair  30  ::   10

imagepairimagepair  13  ::   11

imagepairimagepair  30 :  3
imagepair:  12
: imagepair0
```

```
3imagepair :3  0:
 imagepair3
3imagepair  0:  :3
1imagepair
 imagepair1  0:  :0
 3imagepair
 imagepair0  :3 0
: 3
0imagepair 3 : imagepair3
 3 imagepair: 32
:imagepair  31
 imagepair: 3  1:
 0imagepair
 0imagepair  0:  :0
 imagepair0
2imagepair  :2  0
: imagepair3 2
 imagepair:  0
2imagepair  :3 0
: imagepair3
imagepair3  :3  :3
0imagepair
 imagepair2 :  12
:imagepair  10 :
3
imagepairimagepair  00 :
1 : 0
imagepairimagepair  2 : 3
imagepair3 :  2 :1
 imagepair 22
imagepair:  0
2 : 2
imagepair 3 : 0
imagepair 0 : 0
imagepair 3 : 3
imagepair 1 : 1
imagepair 1 : 2
imagepair 2 : 2
imagepair 0 : 2
imagepair 1 : 2
imagepair 1 : 1
imagepair 0 : 0
imagepair 3 : 0
imagepair 2 : 3
imagepair 0 : 0
imagepair 3 : 3
imagepair 2 : 2
imagepair 3 : 3
imagepair 0 : 2
imagepair 1 : 1
imagepair 3 : 2
imagepair 2 : 2
imagepair 3 : 1
imagepair 3 : 3
imagepair 2 : 2
imagepair 0 : 1
imagepair 2 : 0
imagepair 2 : 2
imagepair 0 : 0
imagepair 2 : 3
imagepair 1 : 2
imagepair 2 : 1
Epoch number 66
 Current loss 0.024869628250598907

imagepairimagepair  31  : : 3
1
imagepair 0imagepair  0:  : 0
0
imagepair imagepair0 :  01
: 3imagepair
 imagepair2  2:  :3
0imagepair
```

```
0imagepair
 imagepair0  2:  :0
2imagepair
 imagepair1  0:  :0
3imagepair
 imagepair0 2 : : 2 3

 imagepairimagepair  31  ::  30

 imagepairimagepair  23  ::  23

 imagepairimagepair  22  ::  21

 imagepairimagepair  33  ::  33

 imagepairimagepair  30  ::  21

 imagepair imagepair2  1:  :2
2imagepair
 imagepair2  3:  :2
1
imagepair imagepair2  0:  :1
0
imagepair imagepair3  3:  :3
3imagepair
 imagepair3  3:  :0
0imagepair
 imagepair0  1:  :0
2imagepair
imagepair 3 3 :  : 3
3imagepair
imagepair  3 0 :: 0
0imagepair
 imagepair3  2:  :1
2
imagepair imagepair2  1:  :0
1imagepair
 3imagepair  :3  1:
 3imagepair
0imagepair  :1  2:
 0imagepair
1imagepair  :2  2:
 2imagepair
 0imagepair  :1  0:
 3imagepair
0imagepair  :0  0:
 0imagepair
3imagepair  :0  2:
 imagepair3
3imagepair  :0  2:
 imagepair1
2 imagepair:  32
: imagepair 01
 imagepair:  11
: imagepair3
2 imagepair:  10
: imagepair1
1 : 0
imagepair 3 : 0
imagepair 2 : 0
imagepair 1 : 1
imagepair 1 : 1
imagepair 2 : 3
imagepair 2 : 2
imagepair 3 : 3
imagepair 2 : 0
imagepair 2 : 3
imagepair 3 : 1
imagepair 1 : 1
imagepair 1 : 2
imagepair 1 : 1
imagepair 3 : 0
imagepair 2 : 1
```

```
imagepair 1 : 1
imagepair 3 : 3
imagepair 0 : 0
imagepair 1 : 0
imagepair 3 : 3
imagepair 1 : 1
imagepair 1 : 0
imagepair 3 : 2
imagepair 2 : 2
imagepair 0 : 1
imagepair 3 : 3
imagepair 1 : 0
imagepair 2 : 2
imagepair 2 : 3
imagepair 0 : 0
imagepair 3 : 3
Epoch number 67
 Current loss 0.015733692795038223


imagepair imagepair2  2 : : 13

imagepair 2 imagepair 2:  3:
 1imagepair
 1imagepair 3 : 3
imagepair 3  :: 3
1
imagepair 3imagepair  1: : 0
 imagepair0
 imagepair1 1 :  :1
 imagepair1
 1imagepair  1 :: 1
 2
imagepairimagepair  03 : 0
 : 2
imagepair imagepair 00  ::  32

imagepairimagepair  23  :: 0
3
imagepairimagepair  33 : 3
imagepair  0 :: 1
imagepair 3
 imagepair 1 : 1
2imagepair : 0 : 3
imagepair  3 : 3
1
imagepair imagepair2  3:  :2
 3imagepair
 imagepair1  : 1 0:
 3
imagepairimagepair  02 :  2:
3imagepair
 1imagepair  1: : 1 1

imagepairimagepair  11 :  3:
imagepair1
 0 imagepair:  3
1 : 1imagepair
 2 imagepair: 3  : 3
0imagepair
0 imagepair :0  1
: imagepair0 1
imagepair  2:  :2
2
imagepair 0imagepair  0:  :0
1
imagepairimagepair 0 : 2  0
: imagepair 02 :
 imagepair3
 2 : imagepair 32
 imagepair:  02
 imagepair:  20
:imagepair  32 :
imagepair  32
```

```
:imagepair 2
3 imagepair: 3  3:
 imagepair3
0 imagepair:  0
1imagepair  0 : 3
:imagepair  2 : 1
0
imagepairimagepair 3 1  : :3
 3
imagepair 3 : 3
imagepair 0 : 0
imagepair 2 : 2
imagepair 1 : 0
imagepair 2 : 2
imagepair 1 : 2
imagepair 1 : 0
imagepair 1 : 0
imagepair 1 : 1
imagepair 3 : 3
imagepair 1 : 0
imagepair 3 : 3
imagepair 3 : 1
imagepair 2 : 1
imagepair 0 : 2
imagepair 0 : 0
imagepair 3 : 3
imagepair 1 : 1
imagepair 1 : 1
imagepair 3 : 1
imagepair 2 : 1
imagepair 0 : 0
imagepair 2 : 3
imagepair 0 : 0
imagepair 3 : 0
imagepair 2 : 0
imagepair 0 : 1
imagepair 1 : 2
imagepair 2 : 3
imagepair 1 : 3
imagepair 2 : 3
imagepair 0 : 1
imagepair 2 : 2
Epoch number 68
 Current loss 0.025066081434488297

imagepairimagepair 0  :1  0:
 2imagepair
1 :imagepair  00 :
3imagepair
imagepair  2 : 22
 imagepair:  20 :
 imagepair0
 0imagepair :  02
:imagepair  00
: imagepair1 2
 :imagepair  2 2
: 1imagepair
1imagepair  3 : :0
 imagepair 2 :2 2

imagepair imagepair3 : 2
 imagepair 23  3:
imagepair: 3
 1 imagepair :2 :  32

imagepairimagepair  2 : 22
 : imagepair 2
3 :imagepair 1
 0imagepair  2 ::  0
2
imagepairimagepair  20 :  : 3
imagepair1
```

```
2 imagepair:  33
 :imagepair  02
imagepair:  00 :
 3
imagepairimagepair 3  0: : 1 2

imagepairimagepair  33  :: 3
 0imagepair 3
 : 3
imagepairimagepair 2 1 : 0 : 0
imagepair
 imagepair0 0  ::  30
imagepair
imagepair 1  : 1
1 : 0
imagepairimagepair  32  ::  30

imagepairimagepair  10 : 3
 :imagepair  1 : 1
0
imagepair 0 imagepair:  20
: imagepair 23
 :imagepair 2
 2imagepair  2: 3
 :imagepair  1
0imagepair : 0
 imagepair0  :3  :2
0imagepair
3 imagepair :0 3
 imagepair:  0:1  1

 imagepair3imagepair  :2  3: 1
imagepair
imagepair  21 :  2
: imagepair2  1: 0

imagepairimagepair 1 2  : :1 2

imagepair 2 : 2
imagepair 2 : 2
imagepair 2 : 1
imagepair 0 : 2
imagepair 0 : 1
imagepair 2 : 1
imagepair 0 : 3
imagepair 2 : 3
imagepair 1 : 1
imagepair 3 : 3
imagepair 0 : 2
imagepair 2 : 0
imagepair 3 : 3
imagepair 0 : 2
imagepair 0 : 0
imagepair 2 : 2
imagepair 2 : 3
imagepair 1 : 1
imagepair 1 : 1
imagepair 3 : 3
imagepair 3 : 3
imagepair 1 : 1
imagepair 2 : 2
imagepair 3 : 0
imagepair 0 : 1
imagepair 1 : 0
imagepair 0 : 0
imagepair 0 : 0
imagepair 3 : 2
imagepair 3 : 3
imagepair 2 : 3
Epoch number 69
 Current loss 0.018017711117863655

 imagepairimagepair 0 1  ::  00
```

```
imagepair 3imagepair :  13
 :imagepair  3
1imagepair  :0  : 30

imagepairimagepair 1 1  :: 1
0
imagepair imagepair2 :  11
: imagepair 02
 :imagepair 1  : 20

imagepair 2imagepair  0: :  03

imagepairimagepair 3 :  21
 imagepair 3:  :2
2
imagepairimagepair  13 :  3
imagepair :1 1
:imagepair  1
1 imagepair : 23
 imagepair :0  1
: 1imagepair
2imagepair  : 0 :2
imagepair 0
1 :imagepair  3
2 : 2imagepair
 0imagepair  0:  :0 0

imagepairimagepair  23  ::  32

imagepair imagepair2  : 12
imagepair: 1 3
 :imagepair 2  : 23

imagepairimagepair  0 : 1
0imagepair1  : 1
 :imagepair  1 :1
 1
imagepair imagepair3 3 2:  :
0imagepair
 imagepair3  :3  0:
 imagepair1
2 imagepair:  32
: 2
imagepair imagepair1  1 ::  1
1
imagepairimagepair  0 1: : 1
0imagepair
 1imagepair 2  :: 2
 imagepair 2
2imagepair :  2
0imagepair  : 30
:imagepair  3 : 00

imagepair 3imagepair 1  : 1
: 3
imagepairimagepair 0 : 0
 0 : 0imagepair
 imagepair0  2:  : 0
2
imagepairimagepair  11 : : 1
1
imagepair imagepair0  :1  0:
3
imagepair 1 : 2
imagepair 3 : 3
imagepair 1 : 1
imagepair 0 : 0
imagepair 3 : 1
imagepair 0 : 0
imagepair 1 : 3
imagepair 0 : 2
imagepair 3 : 3
```

```
imagepair 3 : 3
imagepair 3 : 3
imagepair 0 : 1
imagepair 2 : 1
imagepair 0 : 1
imagepair 1 : 3
imagepair 2 : 2
imagepair 2 : 2
imagepair 3 : 3
imagepair 1 : 1
imagepair 0 : 1
imagepair 2 : 0
imagepair 3 : 0
imagepair 3 : 3
imagepair 2 : 2
imagepair 3 : 1
imagepair 3 : 2
imagepair 3 : 2
imagepair 3 : 3
imagepair 3 : 3
imagepair 3 : 1
imagepair 3 : 1
imagepair 3 : 0
Epoch number 70
 Current loss 0.02656855806708336

imagepairimagepair  1 :1 : 1
 2
imagepairimagepair  1 :1 : 3
 1imagepair
imagepair  11  ::  11

imagepairimagepair 0  :1  0
:imagepair 1
 imagepair2 :  2 : 2
1
imagepair 3 : 2imagepair 0
: 3
imagepairimagepair 2 :  02
 : 0
imagepairimagepair 3  : 3
0imagepair 3  :: 2
 3imagepair
imagepair  23 :  : 2
3imagepair
 1imagepair  1 : :1
3
imagepairimagepair  1 0:  :3
2
imagepairimagepair 2  : 0
1imagepair 1 : : 0 3

imagepairimagepair  12  ::  20

imagepair imagepair2 : 2
imagepair 0 :  0
0imagepair 3  ::  23

imagepair imagepair 2 :3  2
imagepair 1 : : 3
3imagepair
imagepair 0  : 0
1imagepair 0  : 0
: 1imagepair
 0imagepair : 0
 imagepair 13 : :  12

imagepair imagepair1 3 :  3:
 imagepair3
 1 imagepair: 0
1 imagepair: 3
3 : imagepair1
2imagepair : 21
```

```
 imagepair:  21
: 3imagepair
 imagepair 0 0 : : 1
2
imagepairimagepair  20  ::  0
2
imagepair 2imagepair 0  ::  0
imagepair 23
imagepair : 2  :0 2
imagepair 0
imagepair:  2
3 : 3imagepair
imagepair  3 2: :  3
3
imagepairimagepair 0 : 0  :2 3

imagepair 0 : 2
imagepair 2 : 1
imagepair 3 : 3
imagepair 3 : 1
imagepair 1 : 3
imagepair 3 : 3
imagepair 3 : 2
imagepair 0 : 0
imagepair 0 : 0
imagepair 0 : 0
imagepair 2 : 2
imagepair 0 : 2
imagepair 2 : 0
imagepair 3 : 2
imagepair 2 : 2
imagepair 3 : 3
imagepair 1 : 1
imagepair 2
: 2imagepair 1 : 1
imagepair 2 : 3
imagepair 3 : 3
imagepair  0 :0
imagepair 1 : 1
imagepair 2 : 0
imagepair 1 : 1
imagepair 0 : 2
imagepair 2 : 2
imagepair 3 : 3
imagepair 2 : 2
imagepair 0 : 0
imagepair 0 : 0
imagepair 2 : 3
imagepair 3 : 1
Epoch number 71
 Current loss 0.030071813613176346

imagepair imagepair3  3: :  33

imagepair imagepair 03  ::  13

imagepairimagepair  03  ::  13

imagepairimagepair  03 :2
:imagepair  32
:imagepair  32
 imagepair:  32
:imagepair  30
 imagepair:  00
: imagepair0
3imagepair  :3  3:
 imagepair2
3imagepair  :1  1:
 imagepair1
2 :imagepair 1
 2 :imagepair  32
 imagepair:  31
 imagepair: 1  :0
```

```
imagepair : 1  :0
1imagepair
imagepair  1 :2  :0
2imagepair
 2 imagepair:  02
: imagepair 23
 imagepair : 1 2:
 imagepair1
0 imagepair:  0
3 :imagepair  03
 imagepair:  23
:imagepair  00
 imagepair:  00
 imagepair0
2 imagepair:  02
: imagepair0
0imagepair  :0  0:
 imagepair2
2imagepair  :2  2:
 imagepair2
 1imagepair  0:  :0
1imagepair
 imagepair1  2:  :1
2
imagepair imagepair1  3:  :0
2
imagepairimagepair  01  ::  00

imagepairimagepair  10  : : 2
1
imagepair imagepair1  3: :  13

imagepair imagepair 10 : :  01

imagepair imagepair0  :0  0:
 imagepair3
3 imagepair:  2
3imagepair  :0  3:
 imagepair0
2imagepair :  11
 : 3imagepair
 1imagepair :  30
:imagepair 0
imagepair3 3 :  :3 1

imagepair 0 : 1
imagepair 1 : 2
imagepair 2 : 2
imagepair 2 : 1
imagepair 1 : 0
imagepair 1 : 1
imagepair 1 : 0
imagepair 3 : 3
imagepair 3 : 3
imagepair 1 : 2
imagepair 1 : 2
imagepair 0 : 0
imagepair 2 : 2
imagepair 0 : 0
imagepair 3 : 3
imagepair 3 : 2
imagepair 3 : 1
imagepair 0 : 0
imagepair 2 : 1
imagepair 1 : 1
imagepair 0 : 0
imagepair 3 : 3
imagepair 1 : 3
imagepair 1 : 2
imagepair 3 : 2
imagepair 1 : 1
imagepair 2 : 1
imagepair 0 : 0
```

```
imagepair 0 : 2
imagepair 1 : 1
imagepair 1 : 1
Epoch number 72
 Current loss 0.026927277445793152


imagepair imagepair 33  ::  03

imagepair imagepair 33  : 3
: imagepair3
1imagepair 3 : 3 :
 2
imagepairimagepair  2  :1
3 imagepair: 1 : 2
 imagepair 1 : 23


imagepairimagepair 3 2 :  3:
 imagepair3
 3 : 3
imagepairimagepair  11 : : 1 2

imagepairimagepair  22 : 2
 :imagepair 2
0imagepair :  1
2 : imagepair 00
 : 3
imagepair 3 imagepair:  3
0 :imagepair  2
0 : 0
imagepairimagepair  12 :  :3
 0
imagepairimagepair  20  ::  23
imagepair
 0 : imagepair2
3imagepair  :3
2imagepair : 0  :2 0
imagepair
 imagepair1 3 :
: 32imagepair
 3imagepair  2: : 3
3imagepair
 imagepair3 1  ::
 3 imagepair0
 1 : 2
imagepair 0imagepair  1: :  0
2
imagepair 1 imagepair :3 3 :
0
imagepair 2 imagepair 1 : 1
: 1
imagepairimagepair 1  1
 :2imagepair  : 2
1 imagepair 0 : 0
: imagepair1
 imagepair3 1  ::  21


imagepair imagepair1  0: : 0
0
imagepairimagepair  30  : :3 0

imagepairimagepair  33 :  :3
1imagepair
 0imagepair  :2  2:
 1imagepair
0imagepair  :1  1:
 1imagepair
2 : imagepair1
3imagepair  : 33
: 3
imagepairimagepair  0 : 0
0imagepair  1 ::  33

 imagepair 1 : 1
```

```
imagepair 2 : 2
imagepair 0 : 1
imagepair 3 : 3
imagepair 1 : 0
imagepair 2 : 2
imagepair 0 : 3
imagepair 1 : 0
imagepair 0 : 0
imagepair 0 : 0
imagepair 2 : 2
imagepair 0 : 3
imagepair 1 : 1
imagepair 3 : 3
imagepair 2 : 2
imagepair 2 : 2
imagepair 0 : 3
imagepair 1 : 1
imagepair 0 : 1
imagepair 0 : 0
imagepair 2 : 2
imagepair 3 : 3
imagepair 0 : 3
imagepair 2 : 3
imagepair 2 : 2
imagepair 3 : 3
imagepair 1 : 3
imagepair 3 : 2
imagepair 2 : 3
imagepair 1 : 1
Epoch number 73
 Current loss 0.027855046093463898

imagepairimagepair 3  3:  : 20

imagepair 3 : 3
imagepair imagepair1 : 1
 3 imagepair:  23
:imagepair 3
imagepair0  0:  :0
 0imagepair
imagepair  32  ::  31

imagepairimagepair 2  : 12
 :imagepair 3
 imagepair3 0 : 3 :
 0imagepair
 imagepair3 3  ::  13

imagepairimagepair  01  : :0
imagepair 20
 imagepair : 01
 :imagepair  12 :
 2imagepair
 imagepair0 1  ::   1
3
imagepair imagepair1  2 :: 0
1imagepair
0 : 2imagepair
imagepair 3  2 ::  03

imagepair 0 :imagepair  12
imagepair  2: :  30

imagepair 3 : 0
imagepairimagepair 0  : 31
 : imagepair 2 :3 0

imagepairimagepair  31 :  2
: 3
imagepairimagepair 3  3 :: 3
 3
imagepairimagepair 2  0 ::  02
imagepair
```

```
imagepair
3imagepair  :1  3
:imagepair 1
 1 :imagepair  3
3 imagepair :3  :3
1imagepair
1 :imagepair 1
 2imagepair : 0
 imagepair1  3 : 3: 1

imagepairimagepair 1  1: : 0
imagepair3
 1 :imagepair 0  :1
0
imagepair imagepair 03 :  1
:imagepair 3
3 imagepair:  3
0 :imagepair  30
 imagepair: 2  : 02

imagepairimagepair  3 : 3
2 imagepair 0 : :2
 3
imagepair 0 : 0
imagepair 0 : 0
imagepair 2 : 2
imagepair 2 : 2
imagepair 2 : 1
imagepair 1 : 0
imagepair 1 : 0
imagepair 3 : 1
imagepair 1 : 3
imagepair 2 : 0
imagepair 2 : 2
imagepair 0 : 3
imagepair 1 :
2imagepair 1 : 3
imagepair 0 : 0
imagepair 3 : 3
imagepair 0 : 3
imagepair 1 : 1
imagepair 0 : 3
imagepair 1 : 0
imagepair 3 : 1
imagepair 3 : 0
imagepair 3 : 0
imagepair 1 : 0
imagepair 3 : 3
imagepair 0 : 0
imagepair 2 : 1
imagepair 1 : 1
imagepair 1 : 1
imagepair 1 : 3
imagepair 3 : 3
imagepair 2 : 2
imagepair 0 : 0
Epoch number 74
 Current loss 0.015472941100597382

imagepair 0 : imagepair0
1 :imagepair 0
1 :imagepair  11
 imagepair:  20
 imagepair:  30
: imagepair3 3
 imagepair:  1 3:
 imagepair3
1 imagepair :0  3:
 imagepair0
2 imagepair: 3 :  01

imagepairimagepair  22  ::  0
2imagepair
```

```
3 imagepair:  2 : 2
3imagepair
imagepair 1  1 : 1
:imagepair 3 :  0
3
imagepairimagepair  22  : :2
0
imagepair 3 :imagepair  2 3:
imagepair1
 0imagepair  :0 0
:imagepair  3
3imagepair  :2  0:
 imagepair0
imagepair1  :1  1
: imagepair0
0 : 2
imagepairimagepair 2  : 21
 : 3
imagepair 3 : 1
imagepairimagepair  1 : 1
1imagepair  0 : 1
: imagepair1 3
: 3
imagepairimagepair  33 : 2
 imagepair: 0  :3
 imagepair 12
imagepair : 2
imagepair1  :3  1
: imagepair1
1imagepair 1  : :0
imagepair3
 3 :imagepair 3  1:
 imagepair 30
 imagepair:  12
imagepair: 1
0 : imagepair 11
 : 3
imagepairimagepair  2 : 1
3 imagepair: 3
 3 :imagepair 3
 2imagepair  : 1
0 imagepair : 00
: imagepair3 0
:imagepair  11
 imagepair:  20
 :imagepair 2
2imagepair :  23
:imagepair  30
 imagepair:  03
: imagepair0
1 imagepair:  30
: 3
imagepair 2 : 2
imagepair 2 : 2
imagepair 1 : 2
imagepair 3 : 0
imagepair 2 : 0
imagepair 1 : 2
imagepair 1 : 3
imagepair 1 : 1
imagepair 3 : 2
imagepair 2 : 2
imagepair 2 : 1
imagepair 3 : 3
imagepair 3 : 2
imagepair 3 : 2
imagepair 3 : 3
imagepair 0 : 0
imagepair 3 : 3
imagepair 2 : 3
imagepair 0 : 0
imagepair 0 : 0
imagepair 1 : 1
```

```
imagepair 1 : 1
imagepair 0 : 1
imagepair 3 : 2
imagepair 2 : 2
imagepair 3 : 1
imagepair 0 : 3
imagepair 3 : 3
imagepair 1 : 1
imagepair 2 : 2
imagepair 2 : 2
Epoch number 75
 Current loss 0.047552354633808136

imagepair imagepair3  3: 3
 :imagepair  1
0 imagepair:  1
2 :imagepair  2
3 :imagepair  22
:imagepair  30
 imagepair:  02
 imagepair:  33
 imagepair:  33
:imagepair  21
 imagepair 0:  :2
 imagepair0
 0 : 2
imagepairimagepair  21  :: 1
2
imagepairimagepair  30  ::  30
imagepair
imagepair 2  1 : : 1
1
imagepair imagepair3  0:  0:
 3imagepair
 1 : imagepair1 3
 :imagepair 1 0 :0

imagepair 3 : imagepair3
2imagepair 3 :
1:imagepair  02 :
 0imagepair
 2 : 0imagepair
 0 : 0
imagepairimagepair 1 :  1
1imagepair  0 : :2
 1
imagepairimagepair 0  : 1
0imagepair :  1 0:
imagepair1
 imagepair2  : 22
:imagepair  23
 imagepair:  11
 :imagepair 3
1 :imagepair  3
1imagepair  :0 2
 imagepair:  22
:imagepair 0
imagepair 1 :  31
:imagepair  31
 imagepair:  31
:imagepair 3
imagepair  22 : 1 :
 imagepair2
2imagepair  0:  :2
 imagepair3 :3  1

imagepairimagepair 1 : 1
 1 imagepair : 22 : 3

imagepairimagepair 3 :
  23imagepair  2:  : 13

imagepairimagepair 2  2 : 2
```

```
:imagepair 1
3imagepair :  3
0imagepair 0 : : 0
2imagepair
imagepair1 0  ::  01

imagepair 3 : 3
imagepair 0 : 0
imagepair 2 : 3
imagepair 3 : 3
imagepair 3 : 0
imagepair 3 : 2
imagepair 0 : 0
imagepair 1 : 1
imagepair 0 : 1
imagepair 1 : 1
imagepair 2 : 1
imagepair 3 : 0
imagepair 3 : 3
imagepair 0 : 0
imagepair 2 : 2
imagepair 0 : 0
imagepair 0 : 0
imagepair 0 : 2
imagepair 2 : 1
imagepair 1 : 1
imagepair 0 : 2
imagepair 0 : 0
imagepair 0 : 0
imagepair 2 : 2
imagepair 0 : 0
imagepair 1 : 0
imagepair 1 : 2
imagepair 0 : 2
imagepair 0 : 0
imagepair 3 : 2
Epoch number 76
 Current loss 0.02436818554997444

imagepairimagepair  32  ::  20

imagepair 3 imagepair: 1  3:
 2imagepair
 3imagepair  : 00
 imagepair:  03
imagepair: 3 0
 :imagepair  0
0 :imagepair  2 2:
 2
imagepair 0imagepair :  01
 imagepair:  21
 :imagepair  1
0imagepair : 2
imagepair3  0:  3
: imagepair0
1 imagepair :2 1
 imagepair:  0 : 2
imagepair0
 0 imagepair:  11
 : imagepair 1
1 :imagepair  30
 :imagepair 1
 2 imagepair:  22
:imagepair 2 1
 imagepair:  32
 :imagepair  02
:imagepair 0
 3imagepair  :0  :2
imagepair2
2 : 1
imagepair 2 :imagepair  12
:imagepair  01
 : imagepair0
```

```
0 imagepair :3  3:
 imagepair3
 imagepair1 3  : :3
1imagepair
 imagepair0  3:  :3
2imagepair
 imagepair0  2:  :0
2imagepair
 imagepair1  :2  2:
 imagepair 21
 imagepair: 3
 imagepair1  :0  3
: imagepair 0
1imagepair 1 : 1
imagepair:  31
 imagepair:  23
 : imagepair3
 imagepair3 2 : :  31
imagepair
 imagepair 0 :0  :2
1
imagepairimagepair 0:   3
3 imagepair 0 :
 0:imagepair  33 : 3

imagepairimagepair  0  :01
 :imagepair  22
 : 2
imagepairimagepair 1 3  : :3
 imagepair2 1
: 1
imagepair 1 : 1
imagepair 2 : 2
imagepair 3 : 2
imagepair 3 : 3
imagepair 3 : 1
imagepair 1 : 2
imagepair 1 : 1
imagepair 0 : 0
imagepair 0 : 2
imagepair 0 : 0
imagepair 1 : 0
imagepair 0 : 0
imagepair 0 : 3
imagepair 2 : 0
imagepair 1 : 3
imagepair 0 : 3
imagepair 3 : 3
imagepair 0 : 1
imagepair 2 : 2
imagepair 0 : 2
imagepair 2 : 2
imagepair 0 : 3
imagepair 0 : 0
imagepair 2 : 2
imagepair 0 : 1
imagepair 0 : 2
imagepair 2 : 2
imagepair 3 : 3
imagepair 2 : 2
imagepair 3 : 0
imagepair 2 : 2
Epoch number 77
  Current loss 0.03824371472001076

imagepairimagepair 32 :  1:
2
imagepair 2imagepair  : 21
:imagepair  33
imagepair:  23
:imagepair  1
2 : imagepair1
```

```
3 :imagepair  00
: 2
imagepairimagepair  00 :  : 0
1
imagepair 2 imagepair:  31
 : 1
imagepairimagepair  20 :3  : 3

imagepairimagepair  1 : 1 :1
 imagepair 1
0 imagepair: 1 : 1
 0
imagepair imagepair 10 : : 1
imagepair0
imagepair 0  2 : :3
1imagepair
 0 imagepair :0  2: 3

imagepairimagepair 2  :3  :1 3

imagepairimagepair  10  ::  13

imagepairimagepair  2 :3 1
 :imagepair  21
:imagepair   0 :1
0
imagepairimagepair 2  2 ::  00

imagepairimagepair  3 2:  : 1
2imagepair
 imagepair3 :  32
: 3imagepair
imagepair 0  : 3
3imagepair  : 32
 imagepair 3: : 2 3

imagepairimagepair  2 : 22
 imagepair:  22
 :imagepair
2 1 : 1
0imagepair imagepair  0: 0
 : 0imagepair 0
: imagepair0 3 :
0imagepair
imagepair  0 0: 0
 imagepair:  1
3imagepair : 3
 imagepair0  : 1
2 imagepair: 1  : 0
imagepair0
 imagepair0 2 :  2
: 3
imagepairimagepair  10  ::  22

imagepairimagepair  03  : : 0
imagepair3
 imagepair1 : 0 1
 : 3
imagepair 2 : 0
imagepair 1 : 0
imagepair 3 : 1
imagepair 0 : 2
imagepair 3 : 2
imagepair 3 : 3
imagepair 1 : 1
imagepair 0 : 2
imagepair 1 : 1
imagepair 3 : 1
imagepair 1 : 3
imagepair 1 : 2
imagepair 0 : 3
imagepair 1 : 3
imagepair 0 : 2
```

```
imagepair 0 : 0
imagepair 1 : 0
imagepair 2 : 2
imagepair 1 : 0
imagepair 0 : 2
imagepair 1 : 1
imagepair 3 : 2
imagepair 3 : 2
imagepair 3 : 3
imagepair 1 : 1
imagepair 1 : 0
imagepair 3 :
3imagepair 3 : 0
imagepair 0 : 0
imagepair 1 : 0
imagepair 1 : 1
Epoch number 78
 Current loss 0.013413798063993454

imagepairimagepair 1  2: :  2
1
imagepair imagepair2  2 : :1
1
imagepairimagepair  33  ::  2
2
imagepair imagepair2  2:  :3
2imagepair
 imagepair0  2: : 3
 2imagepair
 imagepair1  0: :  3
0imagepair
 2imagepair :  3 2:
 imagepair 2
3imagepair  : 23
imagepair:  22
 imagepair1  : 3
:imagepair  3
1 :imagepair  33:  1

imagepairimagepair 1  : 1
0 imagepair:  0
0 imagepair: 3 :3
 1imagepair
 0imagepair  :2  : 21

imagepairimagepair  3 :1  3:
imagepair2
3imagepair  : 30
imagepair:  0
imagepair 2 :3  : 02

imagepairimagepair  3 2:  3:
 0imagepair
 imagepair 33  : :2
imagepair3
2 imagepair :3 0
imagepair: 2
 imagepair0  0:  0: 1
imagepair
 imagepair0  1:  :2
1imagepair
2 imagepair:  23
imagepair: 0
1 imagepair :2  0
:imagepair 0
2imagepair :  30
:imagepair 3
 0imagepair  0 : 0:
 imagepair 0 0
: 3
imagepair imagepair 12 :  2
imagepair:  0
imagepair3  2 ::  0
```

```
imagepair 3  2 :: 0
3
imagepair 3imagepair  :2 : 3
2imagepair
 0 imagepair: 2 0
 imagepair : 30
 imagepair:  3
1imagepair  :0  :3
0
imagepair imagepair0  3: :  33

imagepairimagepair 0  3: :  03

imagepair 2 : 2
imagepair 3 : 1
imagepair 3 : 1
imagepair 0 : 0
imagepair 2 : 0
imagepair 1 : 3
imagepair 0 : 3
imagepair 1 : 3
imagepair 3 : 3
imagepair 3 : 1
imagepair 0 : 2
imagepair 3 : 1
imagepair 2 : 2
imagepair 3 : 1
imagepair 2 : 2
imagepair 1 : 1
imagepair 3 : 1
imagepair 3 : 3
imagepair 0 : 2
imagepair 3 : 3
imagepair 1 : 1
imagepair 1 : 1
imagepair 3 : 3
imagepair 1 : 2
imagepair 2 : 1
imagepair 3 : 3
imagepair 0 : 3
imagepair 2 : 2
imagepair 2 : 2
imagepair 1 : 3
Epoch number 79
 Current loss 0.018483813852071762

imagepairimagepair  0 3: :  32

imagepairimagepair 3 : 3
 imagepair1 2 :   :1
2
imagepairimagepair  23 :  1:
 3
imagepairimagepair  1 3: 1
 imagepair :1 :
 1 imagepair0
 2imagepair 3  1

2::  imagepairimagepair  21  ::  21

imagepairimagepair  01  ::  31

imagepairimagepair  30  ::  30

imagepairimagepair  13  ::  00

imagepair 1imagepair  2 ::  2
1imagepair
imagepair 1 3  ::  2
3
imagepairimagepair  12  : :3 2

imagepairimagepair  03 : : 0
```

```
          1imagepair
          imagepair  1 3: 1 :
          0
          imagepairimagepair 1 :   11
           imagepair 2 : :2
           imagepair 1
          0imagepair 1  : 1
          : imagepair 03
          : 3imagepair
           imagepair 2 :1  2
          : imagepair 0
          3imagepair  :2  :3
          2imagepair
           3imagepair  : 0 1
          :imagepair 0
           0imagepair : 0
           imagepair2  : 2
          1 imagepair:   1
          1 imagepair: 2 : 2
           1imagepair
           imagepair2  0:  : 11

          imagepairimagepair  2 : 32
           imagepair 0: :  0
          1
          imagepairimagepair 1  :3  3
          imagepair:  33
          :imagepair 3
           imagepair3 0 :  3:
          imagepair0 3
           :imagepair 0 0
           : 2imagepair
           0imagepair :  22 :
          imagepair 2
          1imagepair :  2
          0imagepair :  1
          0imagepair : 1
           1imagepair 0  : 0
          :imagepair  3 2:
           imagepair3
          imagepair  02  :: 1
          imagepair1
          imagepair  11  ::  22

          imagepair 2 : 1
          imagepair 1 : 3
          imagepair 3 :
          3imagepair 1 : 3
          imagepair 3 : 0
          imagepair 2 : 1
          imagepair 0 : 0
          imagepair 2 : 2
          imagepair 1 : 1
          imagepair 2 : 3
          imagepair 2 :
          0imagepair 1 : 3
          imagepair 1 : 1
          imagepair 0 : 3
          imagepair 1 : 1
          imagepair 2 : 2
          imagepair 1 : 1
          imagepair 0 : 2
          imagepair 2 : 2
          imagepair 2 : 3
          imagepair 3 : 2
          imagepair 3 : 1
          imagepair 2 : 0
          imagepair 2 : 2
          imagepair 0 : 0
          Epoch number 80
           Current loss 0.020184485241770744

          imagepair imagepair1 :  3
```

```
1 : 1
imagepairimagepair 12  : :2
 0imagepair
 imagepair1  :1  0:
 1imagepair
0 imagepair:  33
:imagepair  21
 imagepair:  10
: imagepair0 3
 imagepair:  02
:imagepair  30
 imagepair:  30
: 0imagepair
 imagepair 3 0:  2:
 1
imagepairimagepair 1  1:  :1
 imagepair1
1imagepair  : 0 0:
 0imagepair 0
 imagepair: 3 1
 : imagepair0
2 imagepair:  23 :
 3
imagepairimagepair  2 3 :: 3
 0imagepair
3imagepair  0: :  03
imagepair
 1 imagepair:  31
 : imagepair1
 imagepair2 :
1 1 : imagepair0
1 imagepair:  0 3:
0
imagepairimagepair  1 : 32
 : imagepair 00 : 0
imagepair
imagepair  1 : 01
 : 0imagepair
imagepair 3 2  ::  32

imagepairimagepair: 3  1
 imagepair2  3:  3
:imagepair 0 2
imagepair :  13 : 1

imagepair imagepair2 1 : 0
 :imagepair  3
3imagepair  1 : 3:
imagepair2
3 imagepair: 3 3
 :imagepair  33 :
 imagepair3
 imagepair3  0:  :3
0imagepair
imagepair  01  ::  13

imagepairimagepair  13 :  :3
2imagepair
 3 imagepair:  22
 : imagepair2
3imagepair : 2  2
: imagepair2
0 imagepair :2 0
: imagepair2
2imagepair  0: : 3
 3
imagepair 1 : 3
imagepair 1 : 0
imagepair 0 : 1
imagepair 3 : 0
imagepair 3 : 3
imagepair 1 : 1
```

```
imagepair 1 : 0
imagepair 0 : 0
imagepair 1 : 3
imagepair 3 : 0
imagepair 2 : 0
imagepair 0 : 0
imagepair 1 : 1
imagepair 0 : 3
imagepair 3 : 0
imagepair 1 : 1
imagepair 0 : 1
imagepair 3 : 0
imagepair 1 : 1
imagepair 3 : 3
imagepair 3 : 0
imagepair 1 : 1
imagepair 2 : 2
imagepair 1 : 2
imagepair 2 : 1
imagepair 2 : 2
imagepair 1 : 2
imagepair 1 : 3
imagepair 0 : 0
Epoch number 81
 Current loss 0.02153611183166504

imagepairimagepair  00  :: 0
0
imagepair imagepair 30  ::  3
2imagepair
2imagepair  : 20
: imagepair 0 :2
0imagepair 0
 : 3
imagepairimagepair  2 : 2
1 : 1
imagepairimagepair  3:  2
1imagepair  2 : 3
: imagepair1 1  :1

imagepairimagepair  22 : 3
imagepair :  33
: 3
imagepairimagepair  01  : 1: 0

imagepairimagepair  2 : 20
 imagepair :0 2 :
imagepair0
imagepair1 2 : 3
 :imagepair  1 : 11
imagepair
 imagepair 3 : 3
3 :imagepair  0 3:
 imagepair0
 2 :
3imagepairimagepair  0 1: 0
 imagepair :2 : 2
imagepair 0
imagepair 23 :  2:
 2imagepair
imagepair 1  : 3
3imagepair  3 : 2
:imagepair 2
3 imagepair : 13
 imagepair:1
1imagepair  :2 0
 :imagepair  1 2
:imagepair  30 :
 0
imagepair imagepair2  : 0
3imagepair  1:  :3
 imagepair 1 : 13
```

```
imagepair  2 :2
imagepairimagepair 2  : 2
2imagepair : 2 2
:imagepair 3
 3imagepair  0:  3
imagepair: 0 : 2
 0imagepair
2 : 2
imagepairimagepair  02  ::  02

imagepairimagepair  1 :0 0 :
0
imagepairimagepair  20  :: 0 2

imagepair 3 : 3
imagepair 0 : 2
imagepair 3 : 3
imagepair 0 : 0
imagepair 1 : 3
imagepair 3 : 1
imagepair 3 : 3
imagepair 0 : 0
imagepair 2 : 1
imagepair 2 : 2
imagepair 2 : 3
imagepair 3 : 3
imagepair 0 : 1
imagepair 2 : 2
imagepair 2 : 2
imagepair 2 : 0
imagepair 1 : 1
imagepair 2 : 2
imagepair 3 : 3
imagepair 2 : 1
imagepair 0 : 0
imagepair 3 : 3
imagepair 2 : 0
imagepair 1 : 2
imagepair 3 : 1
imagepair 0 : 1
imagepair 3 : 0
imagepair 1 : 2
imagepair 3 : 0
imagepair 0 : 0
imagepair 0 : 3
imagepair 3 : 3
imagepair 2 : 2
imagepair 1 : 1
imagepair 1 : 1
Epoch number 82
 Current loss 0.023180583491921425

imagepairimagepair  1 : 1
1 :imagepair  0
3 : 3
imagepair 0imagepair  2:  0
: imagepair2 1
 : 0
imagepairimagepair  32  :: 0
 0
imagepairimagepair  3 2  :2:
 1
imagepair 0imagepair :  0 : 30

imagepair imagepair2 :  3 2
:imagepair 2
 2 : 1imagepair
1imagepair :  0 : 0
3
imagepairimagepair 1  1 : : 12

imagepair 3imagepair 2  : : 3
3imagepair
```

```
3imagepair
 1imagepair  : 33
: imagepair2 1
 imagepair: 0  1:
2imagepair
 1imagepair  1: 3
 imagepair:  01
: imagepair 31
 imagepair:  21
 : 2imagepair
 2imagepair  1:  : 33

imagepairimagepair 3  :3
imagepair  0 : 2
3imagepair 2 : 2 : 3

imagepairimagepair 1  :3 : 0
 imagepair1
1 imagepair :2  :1
2imagepair
 3imagepair :  23
imagepair:  22 :
 2imagepair
 imagepair2 3 : :  22

imagepairimagepair  1 0: :  3
1imagepair
 1 imagepair:  01
:imagepair 2
 imagepair0  0:  : 02

imagepairimagepair 1  1 : 2:
1
imagepair imagepair3 0 :  0
: imagepair 2
2imagepair  :2 0
 :imagepair  2
2 imagepair:  32
 imagepair :3 2
 imagepair : 1
0imagepair  :0  :3
2imagepair
 2 : 1
imagepair 1 : 2
imagepair 2 : 3
imagepair 3 : 1
imagepair 3 : 2
imagepair 3 : 2
imagepair 0 : 3
imagepair 0 : 3
imagepair 2 : 2
imagepair 3 : 3
imagepair 1 : 1
imagepair 2 : 3
imagepair 3 : 0
imagepair 3 : 3
imagepair 2 : 1
imagepair 3 : 2
imagepair 1 : 0
imagepair 3 : 3
imagepair 1 : 1
imagepair 3 : 0
imagepair 1 : 1
imagepair 3 : 2
imagepair 2 : 2
imagepair 2 : 3
imagepair 0 : 2
imagepair 0 : 2
imagepair 3 : 1
imagepair 1 : 3
imagepair 2 : 2
imagepair 1 : 0
imagepair 0 : 2
```

```
imagepair 1 : 3
imagepair 2 : 0
imagepair 1 : 1
Epoch number 83
 Current loss 0.011761617846786976

imagepair imagepair1 : 2  1:
 2
imagepairimagepair  2 3: 3
 imagepair 3 :: 3
imagepair  2 : 22

imagepair imagepair2  2: :  2
2imagepair
 2imagepair  0 ::2  2

imagepair imagepair 11  ::  02

imagepair 2 imagepair: 1
0 imagepair:  02
 : 2imagepair
 0 imagepair: 1
 1imagepair : 1  :3
imagepair1
1imagepair  :3 2
: imagepair3
imagepair1  : 10
: imagepair 13 :
1
imagepairimagepair  33  ::  33

imagepairimagepair  32 :  3
:imagepair  02
: imagepair0
 0 imagepair:  32
:imagepair  13
 imagepair:  23
 imagepair:  20
 imagepair:  11
: imagepair 3
3 imagepair: 1 3 :
imagepair 2 0
 imagepair:  21
: imagepair0
2imagepair  : 12
: imagepair0
1 imagepair :3  : 3
1imagepair
 2imagepair  : 2
0 imagepair:  3 : 0
3
imagepairimagepair  3 2 ::  1
1
imagepair 2 : 2
imagepairimagepair 3 : 0
imagepair  0 1 :1
: imagepair0
 imagepair2 : 2
imagepair 3:  1
 1imagepair  2 : 2
: imagepair0
 1 :imagepair 2
 0 :imagepair  32
: 2
imagepair 1 : 1
imagepair 2 : 0
imagepair 3 : 3
imagepair 2 : 2
imagepair 0 : 1
imagepair 1 : 2
imagepair 3 : 1
imagepair 2 : 3
imagepair 2 : 3
```

```
imagepair 2 : 3
imagepair 0 : 0
imagepair 2 : 2
imagepair 3 : 2
imagepair 3 : 3
imagepair 3 : 0
imagepair 3 : 3
imagepair 3 : 0
imagepair 1 : 2
imagepair 3 : 3
imagepair 2 : 0
imagepair 0 : 3
imagepair 1 : 1
imagepair 0 : 0
imagepair 1 : 1
imagepair 0 : 3
imagepair 0 : 0
imagepair 1 : 0
imagepair 3 : 2
imagepair 2 : 3
imagepair 2 : 0
imagepair 0 : 0
imagepair 1 : 3
imagepair 0 : 2
imagepair 2 : 3
imagepair 1 : 1
imagepair 3 : 3
imagepair 0 : 1
imagepair 0 : 2
imagepair 1 : 1
Epoch number 84
 Current loss 0.012941916473209858

imagepair 3 : imagepair3
imagepair  1 2: 3
 : 0
imagepairimagepair  1 0 :: 1 2

imagepair imagepair0 :  00
 :imagepair  3 1
: imagepair0
 imagepair0  0: : 0
 1imagepair
 3imagepair  3: : 3
 imagepair 22 : 0

imagepairimagepair  2 : 12
 :imagepair  0
2imagepair : 1 :  1
1
imagepair imagepair1 : 3 0
 :imagepair  10
 :imagepair  1 3:
 0
imagepair 0imagepair  0 : :0
0
imagepairimagepair 3 2 :  :3
0
imagepairimagepair 0 2  : 1
:imagepair 0  : 3
0imagepair
1imagepair 2  : :2
 imagepair 1
2 :imagepair  3
3 imagepair : 0 : 0
2
imagepairimagepair 0 0  :: 0
0
imagepairimagepair  1 2: : 1 2

imagepairimagepair 1 2 :   : 10

imagepair2imagepair  : 2
```

```
 2imagepair 0 : 0
 imagepair:  2
0imagepair  :3 0
 imagepair: 3 :  2
3imagepair
1 imagepair: 3  2
:imagepair 3   3:
imagepair 3
 2 : 2
imagepairimagepair0  :  30
 :imagepair  13 : 1

imagepairimagepair  3 1: :  13

imagepair imagepair2  1 : : 21

imagepairimagepair  11 :  0
: imagepair 12
 : imagepair2
0 imagepair: 0 0
:  imagepair30
:imagepair 1
 3 : 1
imagepair 3 : 0
imagepair 1 : 0
imagepair 2 : 2
imagepair 1 : 2
imagepair 2 : 0
imagepair 0 : 2
imagepair 0 : 0
imagepair 1 : 1
imagepair 3 : 1
imagepair 0 : 0
imagepair 0 : 1
imagepair 3 :
3imagepair 3 : 1
imagepair 1 : 3
imagepair 3 : 3
imagepair 0 : 1
imagepair 2 : 2
imagepair 2 : 2
imagepair 3 : 3
imagepair 3 : 3
imagepair 0 : 0
imagepair 3 : 2
imagepair 2 : 2
imagepair 3 : 2
imagepair 0 : 3
imagepair 0 : 2
imagepair 1 : 2
imagepair 3 : 3
imagepair 2 : 0
imagepair 0 : 0
imagepair 3 : 3
imagepair 3 : 3
imagepair 2 : 1
Epoch number 85
 Current loss 0.019019529223442078

imagepair imagepair 0 : 2 0
: imagepair2 0
 : 3
imagepair imagepair3  1: : 1 3

imagepairimagepair  30 : 3
 imagepair:  33
: imagepair3
 imagepair 13  :: 3
imagepair  3
2imagepair 0  :: 1
 imagepair1
3 imagepair:    11
:imagepair 2
```

```
 imagepair0 : 2
 0imagepair 2  :
0:imagepair 2  :0
0imagepair
 imagepair1  1:  1:
1
imagepair imagepair0  1:  :0
imagepair  3 : 1
imagepair2
 imagepair2  : 1 : 21

imagepairimagepair  03 :
0:imagepair 3 3
 imagepair:  1
1 imagepair:  33
 imagepair: 3 : 3
 3imagepair
2imagepair  1 :
0 :imagepair  01
 : 3
imagepairimagepair 0 : 0
 imagepair3  :2  : 12
imagepair
 imagepair 1 1:  0
: 3
imagepair imagepair1  2:  2:
 imagepair2
3 imagepair : 33
imagepair:  02
 :imagepair  01 :
 0
imagepairimagepair 0 :  2
0 : 1
imagepairimagepair  02  ::  0
0
imagepair 3imagepair  :0 0
 imagepair: 1  0: 1

imagepair: 0  1
imagepair imagepair 10 :
1 :imagepair 0  0
: 0
imagepairimagepair  3 2:  :3 2
imagepair
imagepair  23  : 2
:imagepair 1 2
imagepair  2 : :2 1

imagepairimagepair  23 :  :1
 3
imagepairimagepair  30   :3:
 0
imagepair 3 : 1
imagepair 1 : 2
imagepair 0 : 3
imagepair 1 : 2
imagepair 2 : 0
imagepair 3 : 3
imagepair 2 : 2
imagepair 0 : 0
imagepair 1 : 1
imagepair 1 : 3
imagepair 0 : 2
imagepair 0 : 0
imagepair 3 : 3
imagepair 3 : 1
imagepair 1 : 0
imagepair 0 : 0
imagepair 0 : 3
imagepair 2 : 2
imagepair 1 : 0
imagepair 1 : 0
```

```
imagepair 1 : 0
imagepair 3 : 2
imagepair 2 : 2
imagepair 0 : 1
imagepair 2 : 2
imagepair 2 : 2
imagepair 3 : 0
imagepair 1 : 1
imagepair 1 : 2
imagepair 1 : 1
Epoch number 86
 Current loss 0.019712895154953003

imagepairimagepair  12  : 2:
imagepair 1
2 imagepair:  33
 :imagepair  21 : 2
imagepair 3
 imagepair:  2 :1 0

imagepair 1imagepair  2 ::  01

imagepairimagepair  23  ::  22

imagepairimagepair  12  ::  12

imagepairimagepair  02  ::  22

imagepair imagepair 3 :3  :2 1

imagepairimagepair 2 0 : : 1 2

imagepairimagepair  00  ::  23

imagepairimagepair  02  ::  03

imagepairimagepair  31  ::  01

imagepairimagepair  30  ::  13

imagepairimagepair  33  ::  32

imagepairimagepair  12  ::  12

imagepairimagepair  21  ::  20

imagepairimagepair  02  ::  02

imagepairimagepair  13  ::  1
3
imagepairimagepair  13  ::  22

imagepair imagepair3 0  ::  1
imagepair1
 2imagepair : 0 :  32

imagepairimagepair 1  0:  :2
0
imagepairimagepair  01 :  3:
imagepair 1
 1imagepair :  31
 : 3imagepair
 0imagepair  : 33
:imagepair 0
 2imagepair  0: :  02
imagepair
 3imagepair : 2  1
: 1imagepair
 imagepair2 1 :   : 13
imagepair
 imagepair3  2 ::  1
 3imagepair
 imagepair 3 3 ::  1
```

```
  imagepair0
2 imagepair :0  :2
 2
imagepair 1 : 2
imagepair 2 : 2
imagepair 0 : 0
imagepair 1 : 1
imagepair 2 : 0
imagepair 1 : 3
imagepair 3 : 3
imagepair 2 : 3
imagepair 2 : 2
imagepair 3 : 2
imagepair 2 : 2
imagepair 1 : 1
imagepair 3 : 0
imagepair 3 : 1
imagepair 0 : 3
imagepair 2 : 3
imagepair 1 : 1
imagepair 3 : 1
imagepair 2 : 3
imagepair 1 : 1
imagepair 1 : 1
imagepair 3 : 1
imagepair 3 : 3
imagepair 0 : 1
imagepair 1 : 3
imagepair 2 : 2
imagepair 0 : 3
imagepair 3 : 3
imagepair 3 : 1
imagepair 2 : 2
imagepair 2 : 3
imagepair 3 : 3
imagepair 3 : 3
Epoch number 87
 Current loss 0.016610581427812576

imagepairimagepair  11  ::  11

imagepair 2 : 2
imagepair 1 : 1
imagepairimagepair  31 :  :2
1imagepair
 1 imagepair: 1 1
: imagepair 2 2: 2

imagepairimagepair  32  :: 0
 imagepair3
1imagepair 3  :: 3
 1imagepair
 3 :imagepair  0 3: 1

imagepairimagepair 0  :2 0
 imagepair: 0  : 10

imagepair imagepair0 1  ::  00

imagepair imagepair0  2:  1:
 imagepair3
 imagepair1  0 ::  2
2imagepair 2
 :imagepair  2 2
: 2imagepair
3 imagepair: 2 : 2
 0imagepair
 imagepair0  1:  : 20

imagepairimagepair 1  0: :  32

imagepairimagepair  10 :1
   · ?
```

```
 . 2
imagepairimagepair 1 : 1
1 : imagepair1
 imagepair 23  ::  22

imagepairimagepair  32  ::  22

imagepairimagepair  13  ::  12

imagepair: 2  2imagepair
 imagepair 0
2 :1imagepair  :1  1
: imagepair3
1 imagepair :2 1
: imagepair 12
imagepair:  1 : 1
0
imagepairimagepair 2  :3  3
:imagepair  23
 : imagepair 03
: imagepair2
1 imagepair :1 2
 :imagepair  0
3 imagepair 3:  3:
 1imagepair
 imagepair3  :1 2
imagepair:  31
 : 3
imagepair 3 : 3
imagepair 1 : 3
imagepair 0 : 0
imagepair 0 : 2
imagepair 0 : 1
imagepair 1 : 2
imagepair 3 : 1
imagepair 1 : 0
imagepair 0 : 0
imagepair 1 : 0
imagepair 3 : 2
imagepair 3 : 0
imagepair 2 : 2
imagepair 3 : 0
imagepair 2 : 3
imagepair 1 : 1
imagepair 3 : 1
imagepair 2 : 2
imagepair 1 : 1
imagepair 1 : 3
imagepair 2 : 0
imagepair 2 : 0
imagepair 1 : 2
imagepair 1 : 1
imagepair 2 : 2
imagepair 2 : 2
imagepair 2 : 1
imagepair 2 : 2
imagepair 2 : 0
imagepair 1 : 1
imagepair 0 : 0
imagepair 0 : 3
imagepair 0 : 0
imagepair 0 : 0
imagepair 1 : 1
Epoch number 88
 Current loss 0.014991126954555511

imagepairimagepair 3 0 :  0:
 1
imagepair 0 : imagepair3 0 :
 1imagepair
 0 imagepair:  10
: imagepair1
2 imagepair:  21
```

```
 : imagepair0
2 imagepair :0  2:
 imagepair2
0 imagepair :0  1
: imagepair0
1imagepair  :0  3:
 imagepair2
0imagepair  :0  2:
 1imagepair
 3 imagepair:  00
: imagepair1 0
 imagepair:  31
: imagepair0
3 imagepair:  00
: imagepair0
2 imagepair:  02
: imagepair 0
1 imagepair:  11
: 0imagepair
2imagepair :  0 0:
 imagepair 0 3:
2imagepair
imagepair  1 :1 0
imagepair:  1
2 : 2
imagepairimagepair  12 : : 3
imagepair 1
1 : 1
imagepairimagepair  3 : 0
2imagepair :
20 imagepair : 31
imagepair: 3
1imagepair :  21
:imagepair 1  :0
 2imagepair
0 : imagepair 0
0 imagepair: 2  0:
 2imagepair
 imagepair0  :3 0
: 0
imagepairimagepair  33 :  : 3
3
imagepairimagepair  0 :0  : 0
0imagepair 1
: 1
imagepairimagepair 2 : 2
3imagepair  : 2: 3
 imagepair0
3imagepair : 1
 1imagepair 1  ::   1
1
imagepair imagepair2  1: 2
imagepair :  11
: imagepair1
 0imagepair 2:
 imagepair :2  2 : 01
imagepair
 imagepair 32  : 1:
 3
imagepair 1 : 1
imagepair 2 : 2
imagepair 2 : 2
imagepair 2 : 2
imagepair 2 : 3
imagepair 3 : 3
imagepair 0 : 0
imagepair 1 : 3
imagepair 2 : 2
imagepair 2 : 1
imagepair 3 : 0
imagepair 1 : 2
imagepair 0 : 0
imagepair 0 : 0
```

```
imagepair 3 : 0
imagepair 3 : 3
imagepair 3 : 1
imagepair 0 : 3
imagepair 1 : 1
imagepair 0 : 0
imagepair 0 : 0
imagepair 0 : 2
imagepair 2 : 1
imagepair 2 : 1
imagepair 2 : 0
imagepair 0 : 0
imagepair 2 : 2
imagepair 1 : 0
imagepair 2 : 2
imagepair 1 : 1
Epoch number 89
 Current loss 0.015774592757225037

imagepair imagepair2  :0  : 30

 imagepair 1: 1
imagepair imagepair 12 : 2
 imagepair: 2 : 1
 imagepair 3 : 12


imagepair 0 imagepair: 0  3:
 3imagepair
0imagepair  0:  :
00imagepair
 imagepair 1 : 1  :00


imagepairimagepair  3:  2
imagepair2 : 2
imagepair2  : 0
1imagepair  :2 1
: imagepair0
2imagepair  2:  :2
2
imagepairimagepair  33  ::  2
2imagepair
3imagepair 3  :: 3
imagepair3
 imagepair 0 : 23
 imagepair 2 : 1
:imagepair 3
 imagepair 10 : 0
imagepair  :2  :1
2imagepair 3
 :imagepair  3 :2 3

imagepairimagepair 0  3:  0:
imagepair  2
3 :imagepair 1  : 32

imagepairimagepair 2  : 1
0 imagepair:  0
0 :imagepair  12
: imagepair1
 1imagepair  :3  1:
 3
imagepairimagepair 1 : 1
 imagepair0 : 1
0 imagepair:  2
2 imagepair: 3
 imagepair 00 :  0
:imagepair 2
 imagepair2 :  20
imagepair  2 ::  0
imagepair 10
: 2
imagepair imagepair 2 : 2
```

```
3 : imagepair 21
 imagepair :2  : 2
1
imagepairimagepair  00  :: 3
imagepair0
2imagepair :  2
3 imagepair 0: : 2
 imagepair3
 2 : imagepair1 1
: 1
imagepair imagepair 0 0:  0
: imagepair0
1 : imagepair1
1 : 2
imagepair 2 : 2
imagepair 2 : 0
imagepair 3 : 3
imagepair 2 : 3
imagepair 1 : 1
imagepair 0 : 3
imagepair 0 : 0
imagepair 3 : 0
imagepair 1 : 1
imagepair 0 : 2
imagepair 2 : 0
imagepair 3 : 3
imagepair 1 : 1
imagepair 1 : 0
imagepair 3 : 3
imagepair 0 : 1
imagepair 2 : 2
imagepair 1 : 3
imagepair 2 : 3
imagepair 0 : 0
imagepair 0 : 0
imagepair 2 : 1
imagepair 2 : 3
imagepair 3 : 3
imagepair 1 : 1
imagepair 1 : 2
imagepair 0 : 0
imagepair 0 : 2
imagepair 2 : 0
Epoch number 90
 Current loss 0.011703993193805218

imagepairimagepair  30  ::  3
0
imagepairimagepair  3 :3
3 imagepair: 22
 :imagepair  3 0:
 2
imagepairimagepair 2 : 0
 3 imagepair: 3  :3 1

imagepairimagepair  02  : 0
: imagepair 21
 imagepair:  3 0: 0

imagepairimagepair  20  : 3
imagepair:  22
 imagepair: 1  : 13

imagepair 2imagepair : 0
 imagepair3 : 0
 1 imagepair :1 : 1
 2imagepair
 0imagepair  :2 :  2
0imagepair
0 : 1
imagepair 1imagepair 1 :
 3 : imagepair1 1
 imagepair:  11
```

```
  :1
imagepair imagepair1
 2:  0: 0imagepair
 imagepair2  2:  :0
2
imagepairimagepair  21 :  1
: imagepair3
3imagepair  2 :: 0
 3imagepair
2 :imagepair 0  : 0
imagepair2
3imagepair  :0 0
: 1
imagepair 1imagepair : 2 1
: 2
imagepairimagepair  2 1: 1
 imagepair 0: :  3
imagepair2  1:
1
imagepairimagepair 3 3  : 3
:imagepair  00
: 1
imagepair imagepair3 : 3
 imagepair1  1: :  21

imagepair imagepair3:   33 : 1
imagepair
 2 imagepair: 0  0
: imagepair 3
3imagepair  2: : 2
 3imagepair
imagepair1 3  :: 0
3
imagepairimagepair 2  1: :  21

imagepairimagepair  2 : 1 :3
 1imagepair
 2 imagepair:  22
: 2imagepair
 imagepair1  2: 1
 : 3imagepair
 imagepair1  1:  :1
2
imagepair 1 : 1
imagepair 0 : 0
imagepair 1 : 2
imagepair 2 : 2
imagepair 3 : 3
imagepair 1 : 1
imagepair 2 : 2
imagepair 3 : 3
imagepair 2 : 3
imagepair 0 : 1
imagepair 2 : 2
imagepair 3 : 1
imagepair 0 : 2
imagepair 2 : 0
imagepair 2 : 2
imagepair 3 : 0
imagepair 3 : 2
imagepair 2 : 2
imagepair 1 : 1
imagepair 3 : 3
imagepair 0 : 3
imagepair 3 : 3
imagepair 2 : 3
imagepair 0 : 0
imagepair 0 : 0
imagepair 1 : 2
Epoch number 91
 Current loss 0.013262854889035225

imagepairimagepair  12  : 1:
```

```
imagepairimagepair  12  : 1:
3
imagepair imagepair1 1  :: 1
imagepair  21
 imagepair:  0 2: 1

imagepairimagepair  32  ::  33

imagepairimagepair  21  ::  1
2
imagepairimagepair 3  : 32
 imagepair:  32
 :imagepair  0
0 :
3imagepair 1 :imagepair 0
 2imagepair :  2
2 imagepair : 22
 imagepair: 32
 :imagepair  3
3 :imagepair  23
imagepair:  21
 : imagepair 31 : 2

imagepair 3 : 3
imagepairimagepair 1 :  1
2 imagepair:  20
: imagepair 01 :
 imagepair0
2 imagepair:  22
:imagepair  22
 :imagepair  20
 :imagepair  00
: imagepair3
 0imagepair  :2  0:
 2
imagepair 1 : 0
imagepairimagepair 1 : 1
imagepair 3 3 : 2 :
imagepair 3 3
 :imagepair  0
1imagepair 0 :  0
:imagepair 0
 imagepair1 3 : 2
:imagepair  33
:imagepair  20
:imagepair  2 2:
2imagepair
 imagepair2  0: :  0
2
imagepair 1 : 1
imagepair 3imagepair 1 :  0:
 imagepair 12 :
1imagepair
imagepair 2  :0 1
 : 3imagepair
imagepair  33 : 3
 imagepair:  03 :
 0imagepair
 imagepair3 :  1 : 1
2
imagepairimagepair  00  ::  0
2imagepair
 1imagepair  :0  :2
0
imagepair 0 : 0
imagepair 2 : 2
imagepair 1 : 1
imagepair 3 : 3
imagepair 2 :
1imagepair 2 : 2
imagepair 3 : 3
imagepair 3 : 3
imagepair 3 : 1
```

```
imagepair 0 : 3
imagepair 2 : 0
imagepair 0 : 0
imagepair 2 : 2
imagepair 2 : 2
imagepair 2 : 1
imagepair 1 : 3
imagepair 0 : 3
imagepair 3 : 3
imagepair 0 : 2
imagepair 3 : 3
imagepair 3 : 2
imagepair 0 : 1
imagepair 0 : 0
imagepair 3 : 0
imagepair 1 : 0
imagepair 2 : 3
imagepair 1 : 2
imagepair 1 : 1
imagepair 0 : 0
imagepair 3 : 1
imagepair 3 : 2
imagepair 3 : 2
Epoch number 92
 Current loss 0.010314391925930977

imagepairimagepair  1 2:  :3
2
imagepairimagepair 3  : 3
2 : 2
imagepair 0imagepair :  31
: 3
imagepair imagepair 0 1:  :0
2
imagepair imagepair0 3:  :0
0imagepair
 imagepair0 : 0
 imagepair3  0: 3
imagepair  :0  3:
 0imagepair
3imagepair  : 1
3imagepair  2:  3: 0
imagepair
imagepair 0 0  ::  21

imagepairimagepair  31  : 1:
 3imagepair
2imagepair 1  ::  31

imagepair imagepair 11  : 1: 3

imagepairimagepair  20  ::  02
imagepair
imagepair 2  0: : 1 1

imagepair imagepair 23  ::  23

imagepairimagepair  02  ::  23

imagepair imagepair 2 :1  2:
 1imagepair
 0imagepair  :1  :0 0

imagepair 0  :0
 imagepair2 : imagepair0
 0 imagepair :3 : 3
  imagepair0
imagepair1 : 1
 imagepair 1 2:  1
imagepair: 3 : 3
 imagepair 3 2: 3

imagepairimagepair  3 : 2
```

```
imagepair imagepair   3 : 2
0 imagepair: 0
imagepair 2 :   1
2imagepair :   32 : 0

imagepairimagepair 3  : 3
imagepair3 1 : 1
 imagepair:  2
2imagepair  3:  : 03

imagepair imagepair0 2  :: 0
 0imagepair
 0imagepair  2: : 3
 imagepair0 2 : 2

imagepair 3 : 1
imagepair 1 : 1
imagepair 0 : 3
imagepair 0 : 2
imagepair 2 : 3
imagepair 3 : 0
imagepair 3 : 3
imagepair 0 : 0
imagepair 1 : 0
imagepair 2 : 3
imagepair 0 : 0
imagepair 2 : 3
imagepair 0 : 0
imagepair 0 : 1
imagepair 2 : 2
imagepair 0 : 3
imagepair 0 : 3
imagepair 3 : 0
imagepair 1 : 0
imagepair 3 : 3
imagepair 3 : 1
imagepair 1 : 2
imagepair 2 : 3
imagepair 2 : 2
imagepair 1 : 1
imagepair 0 : 2
imagepair 2 : 2
imagepair 2 : 2
imagepair 2 : 3
imagepair 0 : 1
imagepair 0 : 3
imagepair 0 : 0
imagepair 2 : 1
imagepair 0 : 3
imagepair 1 : 1
Epoch number 93
 Current loss 0.00912424921989441

imagepairimagepair 1  3:  :3 3

imagepair 3imagepair :  1 3
:imagepair  23
 :imagepair  3 3:
1
imagepairimagepair  11 : 1
 imagepair : 3
2imagepair 3  : 3:
 imagepair2
imagepair3  : 3
2 : imagepair 2
imagepair0  0 ::  0
0imagepair
2 imagepair:  20
 : imagepair 22 :
 2imagepair
 imagepair0  2:  :3 2

imagepairimagepair  10  : 2
```

```
: imagepair 10
 : imagepair3
 1 : 1imagepair
 1imagepair  0 ::  01

imagepairimagepair  33  ::  3
3
imagepairimagepair  20  ::  33

imagepair 3imagepair  2 : :2 0

imagepairimagepair 3  : 3
1imagepair  2 : 2
:imagepair 2
 imagepair 32 : 1
 imagepair:  3 : 2
3
imagepairimagepair  3 2 ::  1
3imagepair
2 :imagepair 2
1imagepair 0 : 3
 :imagepair  3 :3 1
imagepair
 2imagepair :  2
0 :imagepair 0
0imagepair : 2
 1imagepair  : 01
 :imagepair 1
2 :imagepair  11
 :imagepair  2
3imagepair  : 23 :
imagepair2
 3imagepair : 3
 1imagepair  1:  : 31

imagepairimagepair  3 1 ::  33

imagepairimagepair  02 :  0:
1
imagepair 1 : imagepair3
0 imagepair: 0 : 0
3
imagepairimagepair  32  ::  32

imagepair imagepair1 2 :  2
: imagepair2
 imagepair3  : 0 3
: 0
imagepair 3 : 3
imagepair 3 : 3
imagepair 0 : 1
imagepair 0 : 2
imagepair 2 : 0
imagepair 2 : 2
imagepair 2 : 0
imagepair 1 : 1
imagepair 3 : 3
imagepair 1 : 1
imagepair 0 : 1
imagepair 0 : 0
imagepair 1 : 3
imagepair 0 : 1
imagepair 2 : 2
imagepair 2 : 1
imagepair 2 : 2
imagepair 1 : 3
imagepair 3 : 2
imagepair 0 : 0
imagepair 3 : 1
imagepair 1 : 3
imagepair 2 : 3
imagepair 0 : 0
imagepair 1 : 1
```

```
imagepair 3 : 3
imagepair 0 : 3
imagepair 1 : 1
Epoch number 94
 Current loss 0.017723463475704193

imagepairimagepair  0 2:   :0 1

imagepair imagepair 31  :: 1
3
imagepairimagepair 1 :3    : 1
2imagepair
 2 :imagepair  12
 :imagepair  01
 :imagepair  12
 imagepair: 1  3:
 0imagepair
1imagepair  0 : :1 3

imagepairimagepair  1 :1 : 1 2

imagepairimagepair  0 :0 0
 :imagepair  13 :
 1
imagepairimagepair 0 2 : 3
:imagepair  00:  1

imagepairimagepair  1 3:  1
: 2imagepair
2 : 0
imagepairimagepair  21 : 1
 imagepair:  10
: imagepair3
0 imagepair:  31
: imagepair3
1imagepair  :0  0:
 imagepair0
1imagepair  :0  1:
 imagepair1
2imagepair : 1 2 :
 imagepair0
1 imagepair:  03
:imagepair  00
 imagepair:  20
:imagepair  11
 :imagepair  01
 imagepair:  33
:imagepair  01
 imagepair:  33
 :imagepair  30
: 3imagepair
 imagepair 2 1:  3:
 imagepair 01
 : imagepair0
 0 : 2
imagepairimagepair 3  : 02
imagepair  2:  2
: imagepair2
0imagepair  :0  :3 3

imagepairimagepair  13  : 1:
 1
imagepairimagepair 3  1:  :3
1imagepair
 3imagepair  :1  3:
 0
imagepair 0 : 3
imagepair 3 : 3
imagepair 0 : 0
imagepair 3 : 3
imagepair 0 : 2
imagepair 2 : 0
```

```
imagepair 2 : 2
imagepair 3 : 1
imagepair 3 : 2
imagepair 1 : 2
imagepair 1 : 1
imagepair 2 : 2
imagepair 0 : 0
imagepair 3 : 1
imagepair 3 : 3
imagepair 0 : 2
imagepair 3 : 3
imagepair 1 : 3
imagepair 2 : 0
imagepair 2 : 1
imagepair 3 : 0
imagepair 2 : 2
imagepair 0 : 0
imagepair 0 : 0
imagepair 1 : 0
imagepair 3 : 1
imagepair 1 : 2
imagepair 0 : 3
imagepair 1 : 1
imagepair 1 : 3
imagepair 2 : 2
imagepair 0 : 2
imagepair 2 : 3
imagepair 3 : 3
imagepair 0 : 3
imagepair 2 : 0
Epoch number 95
 Current loss 0.009181808680295944

imagepair imagepair 23  : :2
imagepair 1
1 :imagepair  12
 imagepair:  21
 : 2imagepair
3 : imagepair 13
imagepair 0 : : 0
imagepair  30
: 2imagepair
imagepair 1  1: :  13

imagepair imagepair3  1 : 1
: imagepair1
 imagepair1  2 ::  00

imagepair imagepair2  : 03
: 0
imagepairimagepair 3  3:  : 33
imagepair
 3imagepair  : 01
: 1imagepair 2
: 0
imagepair imagepair 2 : 0
1 :imagepair  1 : 2
1imagepair
 2 : 2
imagepairimagepair  2 1: 2
 imagepair:  23
: imagepair2
 3 imagepair: 1  2:
 imagepair1
3 : imagepair3
2 imagepair:  12
 : 2imagepair 0
 :imagepair  0 0
: 0imagepair
 imagepair1  : 1
1 :imagepair 1
 imagepair0  :1 0 :
imagepair 2
```

```
 3imagepair : 1  :3 1

imagepairimagepair 2 : 2
 2imagepair  2 : 0
:imagepair 0
 imagepair3 : 3
 0imagepair  3 : :0 1

imagepairimagepair  03  : 3
:imagepair 3 :  3
1imagepair
 imagepair0 : 3
 imagepair3  : 0
2imagepair  3 : :0
2
imagepair 3 imagepair :0  0
:imagepair  13
 imagepair:  22
:imagepair  02
 : imagepair2
 imagepair1  0:  :1
1
imagepair 1 :imagepair  12
: 2
imagepair 2 : 2
imagepair 2 : 2
imagepair 2 : 3
imagepair 1 : 3
imagepair 1 : 1
imagepair 0 : 0
imagepair 3 : 0
imagepair 0 : 0
imagepair 0 : 2
imagepair 0 : 1
imagepair 0 : 0
imagepair 3 : 1
imagepair 0 : 2
imagepair 3 : 3
imagepair 1 : 1
imagepair 3 : 3
imagepair 1 : 0
imagepair 1 : 1
imagepair 1 : 2
imagepair 0 : 0
imagepair 3 : 2
imagepair 0 : 2
imagepair 2 : 2
imagepair 2 : 2
imagepair 0 : 3
imagepair 1 : 1
imagepair 1 : 1
imagepair 3 : 0
imagepair 2 : 3
imagepair 0 : 0
imagepair 1 : 1
imagepair 0 : 0
Epoch number 96
 Current loss 0.012269374914467335

imagepairimagepair  33 :  1
: 1imagepair
3 imagepair: 3  : 3
3imagepair
 1 : 3imagepair
imagepair1  1 : :0
0
imagepair imagepair2  : 02
 :imagepair 3  : 32

imagepair imagepair2 :  3
3 imagepair:  30
imagepair:  03
: 0imagepair
```

```
. 0imagepair
 0imagepair : 1  : 01
imagepair
 imagepair 20 : :  02

imagepair 1 imagepair: 0 2
: 0
imagepair imagepair 3 1: 3 :
 0
imagepairimagepair  01  : :1 3
imagepair
 3 imagepair:  3 :3
 imagepair 31
imagepair : 2 1
 :imagepair 2
3 :
3imagepair 0  :0
imagepair imagepair 03 :   : 11

imagepair 3 imagepair 2: 3
 :imagepair2 1 : 1

imagepair imagepair 1 :3 1
: imagepair 01 :
2
imagepair 3 imagepair: 1  1: 3

imagepair3  : 0
imagepairimagepair 1 :  11
: imagepair2
3 : imagepair3
1imagepair  2 : :0
 0imagepair
 0imagepair :  2
imagepair3  : 0
imagepair2  :2  2:
3imagepair
 imagepair3  2:  :3
0
imagepair imagepair2 : 0
imagepair  2 : 2
0 imagepair:  12
: imagepair1
1 imagepair:  21
: imagepair2
3imagepair 1  :: 0
 imagepair3
2imagepair  :1  1:
 1imagepair
2 : 2
imagepair 2 : 1
imagepair 0 : 0
imagepair 1 : 1
imagepair 3 : 2
imagepair 3 : 3
imagepair 1 : 1
imagepair 0 : 0
imagepair 2 : 0
imagepair 1 : 1
imagepair 2 : 1
imagepair 2 : 2
imagepair 1 : 3
imagepair 2 : 2
imagepair 3 : 3
imagepair 3 : 0
imagepair 1 : 0
imagepair 1 : 1
imagepair 1 : 1
imagepair 0 : 0
imagepair 2 : 2
imagepair 2 : 3
imagepair 1 : 1
imagepair 3 : 1
```

```
imagepair 2 : 0
imagepair 0 : 1
imagepair 0 : 0
imagepair 0 : 0
imagepair 3 : 3
imagepair 0 : 2
imagepair 2 : 2
imagepair 2 : 0
imagepair 1 : 1
imagepair 3 : 1
Epoch number 97
 Current loss 0.012412326410412788


imagepairimagepair 1 2  : :3 2

imagepairimagepair  31 :  :0
 imagepair3 0
 :imagepair  02
 imagepair:  21
 :imagepair  22
 : 2imagepair
2imagepair  :2  3
: imagepair2
 imagepair1  2: :  1
0
imagepairimagepair 2  0:  : 2
0
imagepairimagepair  10  : 0:
 2
imagepair 0 : imagepair2
3 imagepair :3  0:
 imagepair2 2 :
2
imagepairimagepair  0 : 1
3imagepair  1:  :1 1

imagepair imagepair0  0: :  22

imagepairimagepair  3 : 1
3 imagepair: 1
 imagepair 3 : 13
 :imagepair  3:  3
1imagepair
1 : 3
imagepair 1 imagepair  0: 1
: imagepair0
  imagepair0 :3 0
 imagepair 3 ::3
 imagepair 32
imagepair   3: 1
:imagepair 2
 0imagepair  0 ::1
 imagepair0
1imagepair 2  :
2:imagepair  30
 imagepair:  31
:imagepair  01
: imagepair0
3 : 3
imagepairimagepair 3  : 1 :
10imagepair
 1 imagepair:  0
0 imagepair 1 :: 2
0
imagepairimagepair 3 1  ::  12

imagepair imagepair3  :
 00 imagepair :1 : 1
 imagepair 30
:imagepair  2: 2
 0
 imagepair3 : imagepair 23 :
 3
```

```
imagepairimagepair  30  : :3
0imagepair
2 imagepair :0 2
:imagepair   0
3 imagepair 3: : 2
 3imagepair
 2 : 0
imagepair 0 : 2
imagepair 0 : 2
imagepair 0 : 0
imagepair 2 : 2
imagepair 0 : 0
imagepair 1 : 1
imagepair 0 : 3
imagepair 2 : 0
imagepair 0 : 3
imagepair 3 : 1
imagepair 3 : 2
imagepair 3 : 0
imagepair 2 : 2
imagepair 0 : 2
imagepair 2 : 0
imagepair 2 : 1
imagepair 3 : 2
imagepair 0 : 1
imagepair 1 : 1
imagepair 0 : 0
imagepair 3 : 3
imagepair 3 : 0
imagepair 1 : 1
imagepair 3 : 3
imagepair 1 : 1
imagepair 0 : 2
imagepair 3 : 1
imagepair 3 : 2
imagepair 2 : 2
Epoch number 98
 Current loss 0.009810060262680054

imagepair imagepair 1 3: 1
: 1
imagepair 2imagepair :  23
: imagepair2
1 imagepair :0  0:
 2imagepair
 imagepair 22  ::  13

imagepair 1 :imagepair  1
0 imagepair:  00
: imagepair0
 imagepair0  :0  2:
 imagepair0
0imagepair  : 20
 :imagepair 1 3
 imagepair :1  :3
 imagepair2 0 :
 0imagepair
imagepair 3 0  ::  3
2imagepair
 3 : 3
imagepairimagepair  1 : 3
2 imagepair:  21
imagepair:  10
 :2
imagepairimagepair 0  1:  :2
 1
imagepairimagepair 1  :1 2
 :imagepair  0  :0
1imagepair
 2imagepair  :3  2
: imagepair3
imagepair  2 2 :: 2
```

```
    imagepair0
 0 imagepair: 1 0
 imagepair:  31 :
 imagepair3
 1imagepair  :2  : 0
 3imagepair
  0imagepair  2:  1
 : imagepair 3
 2imagepair  :2 0
  :imagepair  0 3: 0

 imagepairimagepair  00 : 1
 : 1imagepair 0
 :imagepair 3
 imagepair1  3: :  3
 2imagepair
 0 :imagepair  00
 : 2imagepair
 2imagepair  :2  1:
 imagepair2
 3imagepair  :1  2:
  3
 imagepair imagepair0 0  : 0:
 0imagepair
  imagepair0  :2  0:
  1
 imagepair 1 : 1
 imagepair 1 : 2
 imagepair 0 : 0
 imagepair 3 : 0
 imagepair 1 : 2
 imagepair 1 : 1
 imagepair 0 : 0
 imagepair 3 : 2
```

▾ Some simple testing

The last 3 subjects were held out from the training, and will be used to test. The Distance between each image pair denotes the degree of similarity the model found between the two images. Less means it found more similar, while higher values indicate it found them to be dissimilar.

```
 imagepair  0 : 0

#!mv ShahidKapoor Sushant testing_data
 imagepair  3 : 2

#folder_dataset_test = dset.ImageFolder(root=Config.testing_dir)
folder_dataset_test = dset.ImageFolder(root='testing_data')
siamese_dataset = SiameseNetworkDataset(imageFolderDataset=folder_dataset_test,
                                        transform=transforms.Compose([transforms.Resize((100,100)),
                                                                      transforms.ToTensor()
                                                                      ])
                                       ,should_invert=False)

test_dataloader = DataLoader(siamese_dataset,num_workers=6,batch_size=1,shuffle=True)
dataiter = iter(test_dataloader)
for j in range(1):
  #dataiter = iter(test_dataloader)

  x0,_,_ = next(dataiter)
  #print(x0)
  for i in range(2):
    _,x1,label2 = next(dataiter)
    #print(label2)
    concatenated = torch.cat((x0,x1),0)

    output1,output2 = net(Variable(x0).cuda(),Variable(x1).cuda())
    euclidean_distance = F.pairwise_distance(output1, output2)
    print(euclidean_distance)
    imshow(torchvision.utils.make_grid(concatenated),'Dissimilarity: {:.2f}'.format(euclidean_distance.item()
```
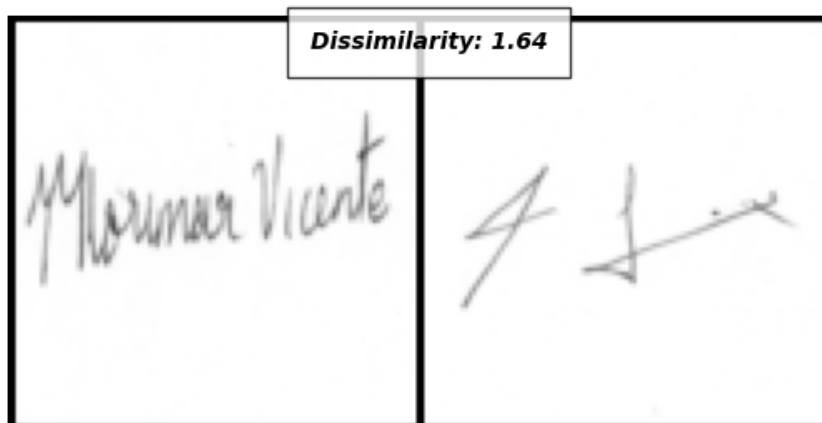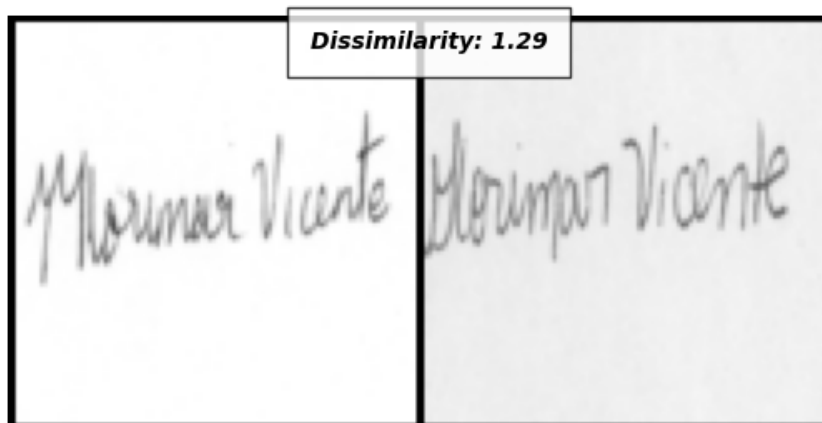
```
imagepair 0imagepair imagepair:  imagepair0  10  :
:1
  10: 1
```

tensor([1.6411], device='cuda:0', grad_fn=<NormBackward1>)

tensor([1.2875], device='cuda:0', grad_fn=<NormBackward1>)


```
checkpoint1 = {'state_dict': net.state_dict()}
torch.save(checkpoint1, './Siemaseteam26v4.pth')
torch.save(net,'SiemeseSignVer.pth')
```

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