t81_558_class_09_4_facial_points

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1 T81-558: Applications of Deep Neural Networks

Module 9: Transfer Learning * Instructor: Jeff Heaton, McKelvey School of Engineering, Washington University in St. Louis * For more information visit the class website.

2 Module 9 Material

- Part 9.1: Introduction to Keras Transfer Learning [Video] [Notebook]
- Part 9.2: Keras Transfer Learning for Computer Vision [Video] [Notebook]
- Part 9.3: Transfer Learning for NLP with Keras [Video] [Notebook]
- **Part 9.4: Transfer Learning for Facial Feature Recognition** [Video] [Notebook]
- Part 9.5: Transfer Learning for Style Transfer [Video] [Notebook]

3 Google CoLab Instructions

The following code ensures that Google CoLab is running the correct version of TensorFlow.

```
[ ]: try:
         %tensorflow_version 2.x
         COLAB = True
         print("Note: using Google CoLab")
     except:
         print("Note: not using Google CoLab")
         COLAB = False
```

Note: using Google CoLab

4 Part 9.4: Transfer Learning for Facial Points and GANs

I designed this notebook to work with Google Colab. You can run it locally; however, you might need to adjust some of the installation scripts contained in this notebook.

This part will see how we can use a 3rd party neural network to detect facial features, particularly the location of an individual's eyes. By locating eyes, we can crop portraits consistently. Previously, we saw that GANs could convert a random vector into a realistic-looking portrait. We can also perform the reverse and convert an actual photograph into a numeric vector. If we convert two images into these vectors, we can produce a video that transforms between the two images.

NVIDIA trained StyleGAN on portraits consistently cropped with the eyes always in the same location. To successfully convert an image to a vector, we must crop the image similarly to how NVIDIA used cropping.

The code presented here allows you to choose a starting and ending image and use StyleGAN2 to produce a "morph" video between the two pictures. The preprocessing code will lock in on the exact positioning of each image, so your crop does not have to be perfect. The main point of your crop is for you to remove anything else that might be confused for a face. If multiple faces are detected, you will receive an error.

Also, make sure you have selected a GPU Runtime from CoLab. Choose "Runtime," then "Change Runtime Type," and choose GPU for "Hardware Accelerator."

These settings allow you to change the high-level configuration. The number of steps determines how long your resulting video is. The video plays at 30 frames a second, so 150 is 5 seconds. You can also specify freeze steps to leave the video unchanged at the beginning and end. You will not likely need to change the network.

```
[ ]: NETWORK = "https://nvlabs-fi-cdn.nvidia.com/"\
    "stylegan2-ada-pytorch/pretrained/ffhq.pkl"
STEPS = 150
FPS = 30
FREEZE_STEPS = 30
```

4.1   Upload Starting and Ending Images

We will begin by uploading a starting and ending image. The Colab service uploads these images. If you are running this code outside of Colab, these images are likely somewhere on your computer, and you provide the path to these files using the **SOURCE** and **TARGET** variables.

Choose your starting image.

```
[ ]: # HIDE OUTPUT
import os
from google.colab import files


uploaded = files.upload()


if len(uploaded) != 1:
  print("Upload exactly 1 file for source.")
else:
  for k, v in uploaded.items():
    _, ext = os.path.splitext(k)
    os.remove(k)
    SOURCE_NAME = f"source{ext}"
    open(SOURCE_NAME, 'wb').write(v)
```

<IPython.core.display.HTML object>

Saving about-jeff-heaton-2020.jpg to about-jeff-heaton-2020.jpg

Also, choose your ending image.

```
# HIDE OUTPUT
uploaded = files.upload()

if len(uploaded) != 1:
  print("Upload exactly 1 file for target.")
else:
  for k, v in uploaded.items():
    _, ext = os.path.splitext(k)
    os.remove(k)
    TARGET_NAME = f"target{ext}"
    open(TARGET_NAME, 'wb').write(v)
```

<IPython.core.display.HTML object>

Saving thor.jpg to thor.jpg

4.2 Install Software

Some software must be installed into Colab, for this notebook to work. We are specifically using these technologies:

- [Training Generative Adversarial Networks with Limited Data](#) Tero Karras, Miika Aittala, Janne Hellsten, Samuli Laine, Jaakko Lehtinen, Timo Aila
- [One-millisecond face alignment with an ensemble of regression trees](#) Vahid Kazemi, Josephine Sullivan

```
# HIDE OUTPUT
!wget http://dlib.net/files/shape_predictor_5_face_landmarks.dat.bz2
!bzip2 -d shape_predictor_5_face_landmarks.dat.bz2
```

```
--2022-01-31 02:50:46--
http://dlib.net/files/shape_predictor_5_face_landmarks.dat.bz2
Resolving dlib.net (dlib.net)… 107.180.26.78
Connecting to dlib.net (dlib.net)|107.180.26.78|:80… connected.
HTTP request sent, awaiting response… 200 OK
Length: 5706710 (5.4M)
Saving to: 'shape_predictor_5_face_landmarks.dat.bz2.1'

shape_predictor_5_f 100%[===================>]   5.44M  22.4MB/s    in 0.2s

2022-01-31 02:50:46 (22.4 MB/s) - 'shape_predictor_5_face_landmarks.dat.bz2.1'
saved [5706710/5706710]

bzip2: Output file shape_predictor_5_face_landmarks.dat already exists.
```

```
# HIDE OUTPUT
import sys
!git clone https://github.com/NVlabs/stylegan2-ada-pytorch.git
```

```
!pip install ninja
sys.path.insert(0, "/content/stylegan2-ada-pytorch")
```

```
fatal: destination path 'stylegan2-ada-pytorch' already exists and is not an
empty directory.
Requirement already satisfied: ninja in /usr/local/lib/python3.7/dist-packages
(1.10.2.3)
```

4.3   Detecting Facial Features

First, I will demonstrate how to detect the facial features we will use for consistent cropping and centering of the images. To accomplish this, we will use the dlib package, a neural network library that gives us access to several pretrained models. The DLIB Face Recognition ResNET Model V1 is the model we will use; This is a 5-point landmarking model which identifies the corners of the eyes and bottom of the nose. The creators of this network trained it on the dlib 5-point face landmark dataset, which consists of 7198 faces.

We begin by initializing dlib and loading the facial features neural network.

```
[ ]: import cv2
     import numpy as np
     from PIL import Image
     import dlib
     from matplotlib import pyplot as plt

     detector = dlib.get_frontal_face_detector()
     predictor = dlib.shape_predictor('shape_predictor_5_face_landmarks.dat')
```

Let's start by looking at the facial features of the source image. The following code detects the five facial features and displays their coordinates.

```
[ ]: img = cv2.imread(SOURCE_NAME)
     if img is None:
         raise ValueError("Source image not found")

     gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
     rects = detector(gray, 0)

     if len(rects) == 0:
       raise ValueError("No faces detected")
     elif len(rects) > 1:
       raise ValueError("Multiple faces detected")

     shape = predictor(gray, rects[0])

     w = img.shape[0]//50

     for i in range(0, 5):
       pt1 = (shape.part(i).x, shape.part(i).y)
```
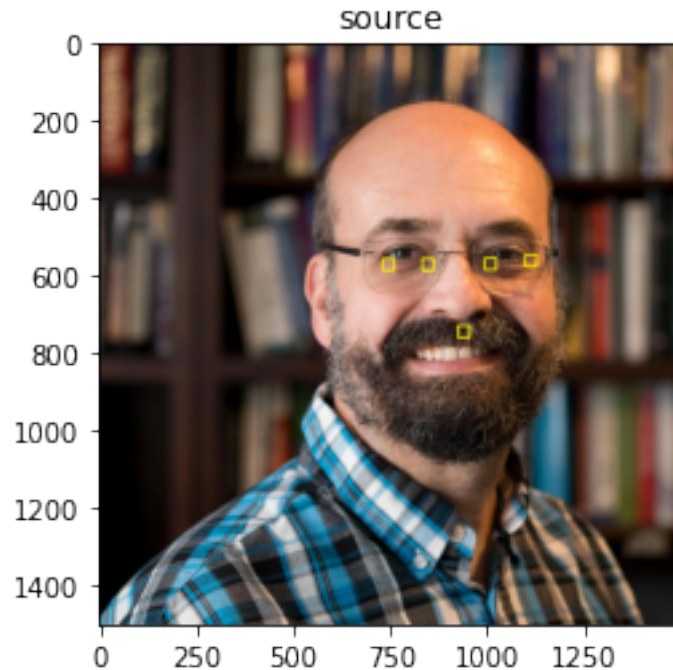
```
    pt2 = (shape.part(i).x+w, shape.part(i).y+w)
    cv2.rectangle(img,pt1,pt2,(0,255,255),4)
    print(pt1,pt2)
```

```
(1098, 546) (1128, 576)
(994, 554) (1024, 584)
(731, 556) (761, 586)
(833, 556) (863, 586)
(925, 729) (955, 759)
```

We can easily plot these features onto the source image. You can see the corners of the eyes and the base of the nose.

```
[ ]: img = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
     plt.imshow(img)
     plt.title('source')
     plt.show()
```


4.4   Preprocess Images for Best StyleGAN Results

Using dlib, we will center and crop the source and target image, using the eye positions as reference. I created two functions to accomplish this task. The first calls dlib and find the locations of the person's eyes. The second uses the eye locations to center the image around the eyes. We do not exactly center; we are offsetting slightly to center, similar to the original StyleGAN training set. I determined this offset by detecting the eyes of a generated StyleGAN face. The distance between the eyes gives us a means of telling how big the face is, which we use to scale the images consistently.

5

```python
[ ]: def find_eyes(img):
    gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
    rects = detector(gray, 0)

    if len(rects) == 0:
      raise ValueError("No faces detected")
    elif len(rects) > 1:
      raise ValueError("Multiple faces detected")

    shape = predictor(gray, rects[0])
    features = []

    for i in range(0, 5):
      features.append((i, (shape.part(i).x, shape.part(i).y)))

    return (int(features[3][1][0] + features[2][1][0]) // 2, \
      int(features[3][1][1] + features[2][1][1]) // 2), \
      (int(features[1][1][0] + features[0][1][0]) // 2, \
      int(features[1][1][1] + features[0][1][1]) // 2)

def crop_stylegan(img):
  left_eye, right_eye = find_eyes(img)
  # Calculate the size of the face
  d = abs(right_eye[0] - left_eye[0])
  z = 255/d
  # Consider the aspect ratio
  ar = img.shape[0]/img.shape[1]
  w = img.shape[1] * z
  img2 = cv2.resize(img, (int(w), int(w*ar)))
  bordersize = 1024
  img3 = cv2.copyMakeBorder(
      img2,
      top=bordersize,
      bottom=bordersize,
      left=bordersize,
      right=bordersize,
      borderType=cv2.BORDER_REPLICATE)

  left_eye2, right_eye2 = find_eyes(img3)

  # Adjust to the offset used by StyleGAN2
  crop1 = left_eye2[0] - 385
  crop0 = left_eye2[1] - 490
  return img3[crop0:crop0+1024,crop1:crop1+1024]
```

The following code will preprocess and crop your images. If you receive an error indicating multiple faces were found, try to crop your image better or obscure the background. If the program does not see a face, then attempt to obtain a clearer and more high-resolution image.

6

```python
image_source = cv2.imread(SOURCE_NAME)
if image_source is None:
    raise ValueError("Source image not found")

image_target = cv2.imread(TARGET_NAME)
if image_target is None:
    raise ValueError("Source image not found")

cropped_source = crop_stylegan(image_source)
cropped_target = crop_stylegan(image_target)

img = cv2.cvtColor(cropped_source, cv2.COLOR_BGR2RGB)
plt.imshow(img)
plt.title('source')
plt.show()

img = cv2.cvtColor(cropped_target, cv2.COLOR_BGR2RGB)
plt.imshow(img)
plt.title('target')
plt.show()

cv2.imwrite("cropped_source.png", cropped_source)
cv2.imwrite("cropped_target.png", cropped_target)

#print(find_eyes(cropped_source))
#print(find_eyes(cropped_target))
```
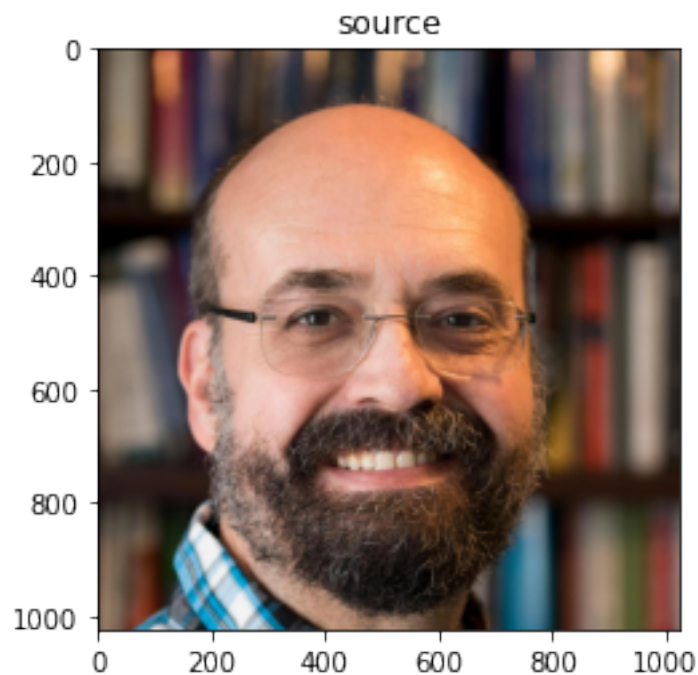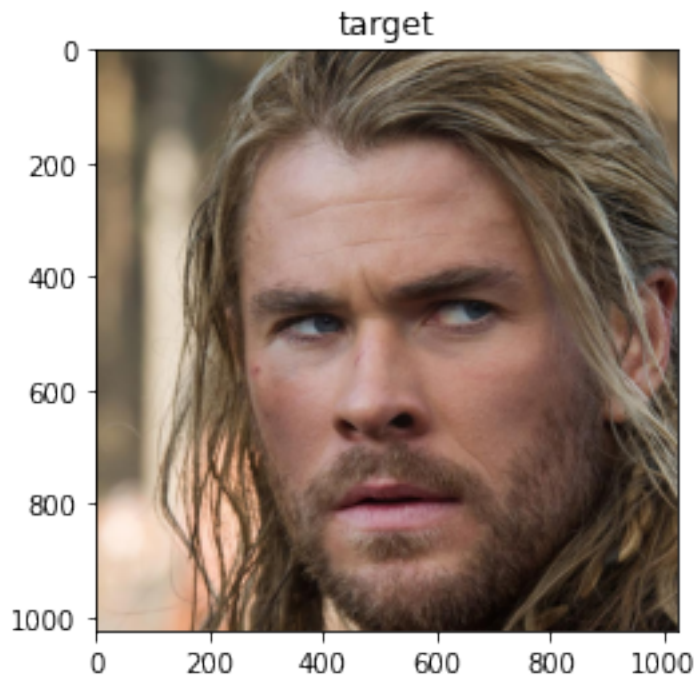

source

target

```
[ ]: True
```

The two images are now 1024x1024 and cropped similarly to the ffhq dataset that NVIDIA used to train StyleGAN.

4.5 Convert Source to a GAN

We will use StyleGAN2, rather than the latest StyleGAN3, because StyleGAN2 contains a projector.py utility that converts images to latent vectors. StyleGAN3 does not have as good support for this projection. First, we convert the source to a GAN latent vector. This process will take several minutes.

```
[ ]: # HIDE OUTPUT
     cmd = f"python /content/stylegan2-ada-pytorch/projector.py "\
       f"--save-video 0 --num-steps 1000 --outdir=out_source "\
       f"--target=cropped_source.png --network={NETWORK}"
     !{cmd}
```

```
Loading networks from "https://nvlabs-fi-cdn.nvidia.com/stylegan2-ada-
pytorch/pretrained/ffhq.pkl"…
Downloading https://nvlabs-fi-cdn.nvidia.com/stylegan2-ada-
pytorch/pretrained/ffhq.pkl … done
Computing W midpoint and stddev using 10000 samples…
Setting up PyTorch plugin "bias_act_plugin"… Done.
```

```
Downloading https://nvlabs-fi-cdn.nvidia.com/stylegan2-ada-
pytorch/pretrained/metrics/vgg16.pt … done
Setting up PyTorch plugin "upfirdn2d_plugin"… Done.
step     1/1000: dist 0.69 loss 24568.84
step     2/1000: dist 0.68 loss 27642.19
step     3/1000: dist 0.69 loss 27167.21
step     4/1000: dist 0.64 loss 26253.41
step     5/1000: dist 0.68 loss 24959.88
step     6/1000: dist 0.67 loss 23356.19
step     7/1000: dist 0.68 loss 21512.25
step     8/1000: dist 0.64 loss 19487.28
step     9/1000: dist 0.65 loss 17341.38
step    10/1000: dist 0.64 loss 15140.43
step    11/1000: dist 0.69 loss 12949.55
step    12/1000: dist 0.66 loss 10820.28
step    13/1000: dist 0.67 loss 8802.95
step    14/1000: dist 0.70 loss 6946.31
step    15/1000: dist 0.68 loss 5316.80
step    16/1000: dist 0.59 loss 3971.21
step    17/1000: dist 0.59 loss 2941.14
step    18/1000: dist 0.66 loss 2216.37
step    19/1000: dist 0.63 loss 1758.90
step    20/1000: dist 0.61 loss 1567.61
step    21/1000: dist 0.58 loss 1602.35
step    22/1000: dist 0.56 loss 1787.89
step    23/1000: dist 0.57 loss 2053.43
step    24/1000: dist 0.57 loss 2327.65
step    25/1000: dist 0.55 loss 2538.83
step    26/1000: dist 0.57 loss 2637.41
step    27/1000: dist 0.56 loss 2603.98
step    28/1000: dist 0.55 loss 2477.22
step    29/1000: dist 0.56 loss 2317.67
step    30/1000: dist 0.56 loss 2120.18
step    31/1000: dist 0.55 loss 1884.70
step    32/1000: dist 0.57 loss 1628.14
step    33/1000: dist 0.57 loss 1388.85
step    34/1000: dist 0.55 loss 1184.02
step    35/1000: dist 0.56 loss 1026.62
step    36/1000: dist 0.54 loss 909.77
step    37/1000: dist 0.55 loss 830.95
step    38/1000: dist 0.55 loss 805.37
step    39/1000: dist 0.53 loss 812.69
step    40/1000: dist 0.53 loss 834.78
step    41/1000: dist 0.52 loss 828.74
step    42/1000: dist 0.53 loss 761.30
step    43/1000: dist 0.56 loss 651.21
step    44/1000: dist 0.52 loss 521.51
step    45/1000: dist 0.50 loss 402.90
```

```
step    46/1000: dist 0.50 loss 318.31
step    47/1000: dist 0.55 loss 263.56
step    48/1000: dist 0.53 loss 241.12
step    49/1000: dist 0.49 loss 251.14
step    50/1000: dist 0.51 loss 304.16
step    51/1000: dist 0.50 loss 369.90
step    52/1000: dist 0.52 loss 402.65
step    53/1000: dist 0.53 loss 403.27
step    54/1000: dist 0.54 loss 373.34
step    55/1000: dist 0.48 loss 286.43
step    56/1000: dist 0.49 loss 204.31
step    57/1000: dist 0.48 loss 142.15
step    58/1000: dist 0.49 loss 72.53
step    59/1000: dist 0.49 loss 64.59
step    60/1000: dist 0.49 loss 60.36
step    61/1000: dist 0.48 loss 57.51
step    62/1000: dist 0.48 loss 96.37
step    63/1000: dist 0.49 loss 109.48
step    64/1000: dist 0.47 loss 129.66
step    65/1000: dist 0.49 loss 132.66
step    66/1000: dist 0.49 loss 117.68
step    67/1000: dist 0.48 loss 103.61
step    68/1000: dist 0.49 loss 69.93
step    69/1000: dist 0.47 loss 52.00
step    70/1000: dist 0.48 loss 27.73
step    71/1000: dist 0.47 loss 19.48
step    72/1000: dist 0.47 loss 19.65
step    73/1000: dist 0.47 loss 20.25
step    74/1000: dist 0.47 loss 29.61
step    75/1000: dist 0.47 loss 33.64
step    76/1000: dist 0.46 loss 39.67
step    77/1000: dist 0.47 loss 36.08
step    78/1000: dist 0.46 loss 32.92
step    79/1000: dist 0.46 loss 31.11
step    80/1000: dist 0.47 loss 26.28
step    81/1000: dist 0.48 loss 22.76
step    82/1000: dist 0.48 loss 13.80
step    83/1000: dist 0.46 loss 12.49
step    84/1000: dist 0.48 loss 16.18
step    85/1000: dist 0.45 loss 15.87
step    86/1000: dist 0.44 loss 12.29
step    87/1000: dist 0.46 loss 10.47
step    88/1000: dist 0.48 loss 12.08
step    89/1000: dist 0.46 loss 10.22
step    90/1000: dist 0.45 loss 7.48
step    91/1000: dist 0.49 loss 6.97
step    92/1000: dist 0.45 loss 6.56
step    93/1000: dist 0.48 loss 7.02
```

```
step   94/1000: dist 0.46 loss 8.58
step   95/1000: dist 0.45 loss 10.76
step   96/1000: dist 0.47 loss 12.40
step   97/1000: dist 0.48 loss 11.84
step   98/1000: dist 0.45 loss 9.08
step   99/1000: dist 0.45 loss 6.71
step  100/1000: dist 0.45 loss 7.39
step  101/1000: dist 0.43 loss 9.75
step  102/1000: dist 0.43 loss 9.56
step  103/1000: dist 0.43 loss 5.58
step  104/1000: dist 0.44 loss 2.44
step  105/1000: dist 0.44 loss 4.01
step  106/1000: dist 0.45 loss 7.38
step  107/1000: dist 0.43 loss 8.32
step  108/1000: dist 0.43 loss 6.85
step  109/1000: dist 0.42 loss 5.39
step  110/1000: dist 0.44 loss 5.18
step  111/1000: dist 0.45 loss 5.21
step  112/1000: dist 0.43 loss 4.84
step  113/1000: dist 0.44 loss 4.69
step  114/1000: dist 0.43 loss 5.06
step  115/1000: dist 0.43 loss 5.76
step  116/1000: dist 0.42 loss 6.62
step  117/1000: dist 0.43 loss 7.34
step  118/1000: dist 0.44 loss 7.84
step  119/1000: dist 0.42 loss 9.06
step  120/1000: dist 0.44 loss 11.57
step  121/1000: dist 0.43 loss 12.81
step  122/1000: dist 0.42 loss 8.81
step  123/1000: dist 0.43 loss 2.64
step  124/1000: dist 0.41 loss 2.90
step  125/1000: dist 0.42 loss 7.96
step  126/1000: dist 0.41 loss 8.38
step  127/1000: dist 0.43 loss 3.88
step  128/1000: dist 0.42 loss 2.75
step  129/1000: dist 0.41 loss 4.95
step  130/1000: dist 0.42 loss 4.01
step  131/1000: dist 0.42 loss 1.47
step  132/1000: dist 0.43 loss 2.52
step  133/1000: dist 0.41 loss 4.18
step  134/1000: dist 0.40 loss 3.20
step  135/1000: dist 0.42 loss 3.41
step  136/1000: dist 0.41 loss 6.76
step  137/1000: dist 0.44 loss 10.63
step  138/1000: dist 0.42 loss 14.50
step  139/1000: dist 0.41 loss 15.30
step  140/1000: dist 0.42 loss 8.50
step  141/1000: dist 0.42 loss 3.20
```

```
step  142/1000: dist 0.41 loss 8.34
step  143/1000: dist 0.40 loss 13.73
step  144/1000: dist 0.40 loss 11.53
step  145/1000: dist 0.41 loss 13.75
step  146/1000: dist 0.39 loss 23.21
step  147/1000: dist 0.42 loss 23.69
step  148/1000: dist 0.41 loss 13.22
step  149/1000: dist 0.40 loss 7.29
step  150/1000: dist 0.42 loss 8.80
step  151/1000: dist 0.42 loss 10.39
step  152/1000: dist 0.41 loss 10.74
step  153/1000: dist 0.39 loss 10.47
step  154/1000: dist 0.40 loss 12.42
step  155/1000: dist 0.40 loss 20.22
step  156/1000: dist 0.40 loss 27.15
step  157/1000: dist 0.39 loss 24.20
step  158/1000: dist 0.42 loss 17.26
step  159/1000: dist 0.40 loss 14.65
step  160/1000: dist 0.40 loss 13.90
step  161/1000: dist 0.40 loss 13.30
step  162/1000: dist 0.39 loss 15.58
step  163/1000: dist 0.41 loss 20.83
step  164/1000: dist 0.41 loss 22.71
step  165/1000: dist 0.43 loss 19.80
step  166/1000: dist 0.40 loss 17.83
step  167/1000: dist 0.39 loss 17.91
step  168/1000: dist 0.40 loss 14.52
step  169/1000: dist 0.40 loss 10.05
step  170/1000: dist 0.39 loss 8.76
step  171/1000: dist 0.38 loss 7.54
step  172/1000: dist 0.40 loss 7.03
step  173/1000: dist 0.38 loss 9.81
step  174/1000: dist 0.40 loss 9.86
step  175/1000: dist 0.41 loss 4.71
step  176/1000: dist 0.39 loss 2.85
step  177/1000: dist 0.39 loss 5.94
step  178/1000: dist 0.41 loss 6.41
step  179/1000: dist 0.39 loss 3.66
step  180/1000: dist 0.39 loss 2.83
step  181/1000: dist 0.40 loss 3.92
step  182/1000: dist 0.41 loss 4.22
step  183/1000: dist 0.38 loss 3.22
step  184/1000: dist 0.39 loss 2.18
step  185/1000: dist 0.39 loss 2.63
step  186/1000: dist 0.38 loss 4.38
step  187/1000: dist 0.38 loss 5.70
step  188/1000: dist 0.39 loss 7.27
step  189/1000: dist 0.40 loss 11.58
```

```
step  190/1000: dist 0.38 loss 18.20
step  191/1000: dist 0.38 loss 22.91
step  192/1000: dist 0.38 loss 19.88
step  193/1000: dist 0.40 loss 10.03
step  194/1000: dist 0.38 loss 7.92
step  195/1000: dist 0.39 loss 16.66
step  196/1000: dist 0.39 loss 19.63
step  197/1000: dist 0.38 loss 12.89
step  198/1000: dist 0.38 loss 13.33
step  199/1000: dist 0.38 loss 20.81
step  200/1000: dist 0.38 loss 17.69
step  201/1000: dist 0.39 loss 7.83
step  202/1000: dist 0.39 loss 6.01
step  203/1000: dist 0.36 loss 7.21
step  204/1000: dist 0.39 loss 6.24
step  205/1000: dist 0.38 loss 8.44
step  206/1000: dist 0.38 loss 9.41
step  207/1000: dist 0.38 loss 4.84
step  208/1000: dist 0.37 loss 3.23
step  209/1000: dist 0.38 loss 6.27
step  210/1000: dist 0.37 loss 8.15
step  211/1000: dist 0.37 loss 10.04
step  212/1000: dist 0.38 loss 11.97
step  213/1000: dist 0.38 loss 11.18
step  214/1000: dist 0.37 loss 9.16
step  215/1000: dist 0.38 loss 6.61
step  216/1000: dist 0.37 loss 3.30
step  217/1000: dist 0.37 loss 3.33
step  218/1000: dist 0.37 loss 6.29
step  219/1000: dist 0.37 loss 6.12
step  220/1000: dist 0.36 loss 3.18
step  221/1000: dist 0.37 loss 2.60
step  222/1000: dist 0.37 loss 4.20
step  223/1000: dist 0.37 loss 5.04
step  224/1000: dist 0.37 loss 4.37
step  225/1000: dist 0.37 loss 3.59
step  226/1000: dist 0.37 loss 4.55
step  227/1000: dist 0.37 loss 6.34
step  228/1000: dist 0.37 loss 5.99
step  229/1000: dist 0.37 loss 3.80
step  230/1000: dist 0.37 loss 2.65
step  231/1000: dist 0.36 loss 2.51
step  232/1000: dist 0.37 loss 1.80
step  233/1000: dist 0.37 loss 1.14
step  234/1000: dist 0.37 loss 1.69
step  235/1000: dist 0.37 loss 2.71
step  236/1000: dist 0.37 loss 2.88
step  237/1000: dist 0.36 loss 2.07
```

```
step  238/1000: dist 0.37 loss 1.26
step  239/1000: dist 0.36 loss 1.30
step  240/1000: dist 0.37 loss 2.15
step  241/1000: dist 0.36 loss 3.45
step  242/1000: dist 0.36 loss 5.85
step  243/1000: dist 0.36 loss 10.44
step  244/1000: dist 0.36 loss 16.26
step  245/1000: dist 0.37 loss 18.68
step  246/1000: dist 0.37 loss 11.90
step  247/1000: dist 0.37 loss 2.40
step  248/1000: dist 0.36 loss 2.70
step  249/1000: dist 0.36 loss 10.08
step  250/1000: dist 0.38 loss 11.57
step  251/1000: dist 0.36 loss 8.12
step  252/1000: dist 0.35 loss 13.61
step  253/1000: dist 0.35 loss 25.04
step  254/1000: dist 0.36 loss 24.02
step  255/1000: dist 0.36 loss 9.58
step  256/1000: dist 0.36 loss 2.80
step  257/1000: dist 0.36 loss 9.33
step  258/1000: dist 0.36 loss 12.41
step  259/1000: dist 0.35 loss 6.26
step  260/1000: dist 0.37 loss 3.37
step  261/1000: dist 0.35 loss 7.18
step  262/1000: dist 0.36 loss 6.98
step  263/1000: dist 0.36 loss 3.34
step  264/1000: dist 0.36 loss 5.19
step  265/1000: dist 0.36 loss 8.05
step  266/1000: dist 0.36 loss 7.96
step  267/1000: dist 0.36 loss 12.16
step  268/1000: dist 0.36 loss 18.35
step  269/1000: dist 0.37 loss 17.42
step  270/1000: dist 0.37 loss 10.68
step  271/1000: dist 0.36 loss 4.65
step  272/1000: dist 0.36 loss 3.72
step  273/1000: dist 0.37 loss 9.11
step  274/1000: dist 0.36 loss 11.94
step  275/1000: dist 0.36 loss 7.31
step  276/1000: dist 0.36 loss 7.62
step  277/1000: dist 0.35 loss 16.34
step  278/1000: dist 0.35 loss 22.40
step  279/1000: dist 0.35 loss 25.18
step  280/1000: dist 0.35 loss 28.86
step  281/1000: dist 0.36 loss 28.18
step  282/1000: dist 0.37 loss 24.31
step  283/1000: dist 0.36 loss 24.22
step  284/1000: dist 0.35 loss 24.12
step  285/1000: dist 0.35 loss 21.50
```

```
step  286/1000: dist 0.35 loss 22.67
step  287/1000: dist 0.36 loss 28.68
step  288/1000: dist 0.34 loss 29.07
step  289/1000: dist 0.37 loss 19.28
step  290/1000: dist 0.36 loss 13.45
step  291/1000: dist 0.35 loss 19.68
step  292/1000: dist 0.35 loss 26.27
step  293/1000: dist 0.35 loss 25.12
step  294/1000: dist 0.35 loss 21.81
step  295/1000: dist 0.36 loss 22.30
step  296/1000: dist 0.35 loss 26.51
step  297/1000: dist 0.36 loss 29.40
step  298/1000: dist 0.35 loss 25.66
step  299/1000: dist 0.34 loss 20.94
step  300/1000: dist 0.34 loss 22.96
step  301/1000: dist 0.34 loss 24.71
step  302/1000: dist 0.35 loss 20.26
step  303/1000: dist 0.36 loss 14.66
step  304/1000: dist 0.35 loss 10.48
step  305/1000: dist 0.34 loss 8.68
step  306/1000: dist 0.34 loss 12.03
step  307/1000: dist 0.34 loss 14.06
step  308/1000: dist 0.35 loss 7.56
step  309/1000: dist 0.35 loss 2.77
step  310/1000: dist 0.35 loss 7.47
step  311/1000: dist 0.35 loss 10.36
step  312/1000: dist 0.34 loss 5.24
step  313/1000: dist 0.35 loss 2.05
step  314/1000: dist 0.34 loss 5.11
step  315/1000: dist 0.35 loss 7.07
step  316/1000: dist 0.35 loss 5.08
step  317/1000: dist 0.34 loss 4.33
step  318/1000: dist 0.35 loss 7.67
step  319/1000: dist 0.34 loss 12.37
step  320/1000: dist 0.34 loss 16.78
step  321/1000: dist 0.35 loss 20.85
step  322/1000: dist 0.34 loss 21.44
step  323/1000: dist 0.33 loss 16.52
step  324/1000: dist 0.33 loss 14.56
step  325/1000: dist 0.34 loss 18.90
step  326/1000: dist 0.34 loss 18.37
step  327/1000: dist 0.35 loss 8.28
step  328/1000: dist 0.34 loss 2.29
step  329/1000: dist 0.35 loss 8.59
step  330/1000: dist 0.34 loss 13.68
step  331/1000: dist 0.34 loss 7.50
step  332/1000: dist 0.35 loss 1.79
step  333/1000: dist 0.35 loss 5.54
```

```
step  334/1000: dist 0.34 loss 8.76
step  335/1000: dist 0.35 loss 5.35
step  336/1000: dist 0.34 loss 3.83
step  337/1000: dist 0.33 loss 7.30
step  338/1000: dist 0.34 loss 9.16
step  339/1000: dist 0.34 loss 9.84
step  340/1000: dist 0.35 loss 14.98
step  341/1000: dist 0.34 loss 21.81
step  342/1000: dist 0.34 loss 25.12
step  343/1000: dist 0.34 loss 24.57
step  344/1000: dist 0.34 loss 20.08
step  345/1000: dist 0.34 loss 13.54
step  346/1000: dist 0.35 loss 13.06
step  347/1000: dist 0.34 loss 19.40
step  348/1000: dist 0.33 loss 20.69
step  349/1000: dist 0.33 loss 10.90
step  350/1000: dist 0.33 loss 2.13
step  351/1000: dist 0.35 loss 5.08
step  352/1000: dist 0.34 loss 12.02
step  353/1000: dist 0.34 loss 11.44
step  354/1000: dist 0.34 loss 6.04
step  355/1000: dist 0.34 loss 5.80
step  356/1000: dist 0.34 loss 11.18
step  357/1000: dist 0.34 loss 16.00
step  358/1000: dist 0.34 loss 18.66
step  359/1000: dist 0.34 loss 18.86
step  360/1000: dist 0.33 loss 13.73
step  361/1000: dist 0.33 loss 5.32
step  362/1000: dist 0.34 loss 3.06
step  363/1000: dist 0.33 loss 7.89
step  364/1000: dist 0.33 loss 10.21
step  365/1000: dist 0.33 loss 5.65
step  366/1000: dist 0.32 loss 1.92
step  367/1000: dist 0.34 loss 4.22
step  368/1000: dist 0.33 loss 6.29
step  369/1000: dist 0.33 loss 3.76
step  370/1000: dist 0.33 loss 1.72
step  371/1000: dist 0.33 loss 3.26
step  372/1000: dist 0.33 loss 3.86
step  373/1000: dist 0.34 loss 1.95
step  374/1000: dist 0.33 loss 1.59
step  375/1000: dist 0.33 loss 2.97
step  376/1000: dist 0.32 loss 2.49
step  377/1000: dist 0.33 loss 1.11
step  378/1000: dist 0.32 loss 1.87
step  379/1000: dist 0.34 loss 3.21
step  380/1000: dist 0.33 loss 3.13
step  381/1000: dist 0.33 loss 4.06
```

```
step  382/1000: dist 0.32 loss 7.84
step  383/1000: dist 0.32 loss 13.22
step  384/1000: dist 0.32 loss 19.29
step  385/1000: dist 0.32 loss 23.98
step  386/1000: dist 0.33 loss 21.28
step  387/1000: dist 0.33 loss 13.27
step  388/1000: dist 0.33 loss 12.23
step  389/1000: dist 0.32 loss 21.08
step  390/1000: dist 0.32 loss 27.59
step  391/1000: dist 0.32 loss 24.08
step  392/1000: dist 0.32 loss 17.60
step  393/1000: dist 0.33 loss 14.27
step  394/1000: dist 0.33 loss 11.27
step  395/1000: dist 0.33 loss 8.59
step  396/1000: dist 0.32 loss 9.70
step  397/1000: dist 0.33 loss 11.47
step  398/1000: dist 0.32 loss 7.58
step  399/1000: dist 0.32 loss 3.13
step  400/1000: dist 0.32 loss 5.77
step  401/1000: dist 0.32 loss 9.09
step  402/1000: dist 0.32 loss 5.23
step  403/1000: dist 0.33 loss 1.28
step  404/1000: dist 0.32 loss 3.82
step  405/1000: dist 0.32 loss 5.91
step  406/1000: dist 0.32 loss 3.10
step  407/1000: dist 0.32 loss 1.62
step  408/1000: dist 0.32 loss 3.26
step  409/1000: dist 0.32 loss 3.00
step  410/1000: dist 0.32 loss 1.46
step  411/1000: dist 0.32 loss 2.15
step  412/1000: dist 0.32 loss 2.80
step  413/1000: dist 0.32 loss 1.41
step  414/1000: dist 0.32 loss 0.93
step  415/1000: dist 0.31 loss 2.13
step  416/1000: dist 0.32 loss 2.36
step  417/1000: dist 0.33 loss 1.89
step  418/1000: dist 0.32 loss 2.89
step  419/1000: dist 0.32 loss 5.33
step  420/1000: dist 0.32 loss 9.25
step  421/1000: dist 0.33 loss 16.09
step  422/1000: dist 0.32 loss 24.57
step  423/1000: dist 0.32 loss 26.95
step  424/1000: dist 0.31 loss 19.15
step  425/1000: dist 0.32 loss 11.93
step  426/1000: dist 0.32 loss 17.14
step  427/1000: dist 0.31 loss 23.52
step  428/1000: dist 0.32 loss 15.46
step  429/1000: dist 0.31 loss 3.44
```

```
step  430/1000: dist 0.32 loss 6.88
step  431/1000: dist 0.31 loss 17.01
step  432/1000: dist 0.31 loss 16.33
step  433/1000: dist 0.31 loss 11.61
step  434/1000: dist 0.31 loss 13.26
step  435/1000: dist 0.31 loss 13.25
step  436/1000: dist 0.31 loss 7.99
step  437/1000: dist 0.31 loss 5.13
step  438/1000: dist 0.31 loss 4.27
step  439/1000: dist 0.31 loss 3.72
step  440/1000: dist 0.31 loss 6.71
step  441/1000: dist 0.31 loss 7.85
step  442/1000: dist 0.32 loss 3.05
step  443/1000: dist 0.31 loss 1.01
step  444/1000: dist 0.31 loss 3.84
step  445/1000: dist 0.31 loss 4.11
step  446/1000: dist 0.31 loss 2.56
step  447/1000: dist 0.32 loss 2.66
step  448/1000: dist 0.31 loss 2.22
step  449/1000: dist 0.31 loss 1.51
step  450/1000: dist 0.31 loss 2.12
step  451/1000: dist 0.31 loss 2.16
step  452/1000: dist 0.31 loss 1.58
step  453/1000: dist 0.31 loss 1.72
step  454/1000: dist 0.31 loss 1.64
step  455/1000: dist 0.31 loss 1.62
step  456/1000: dist 0.31 loss 2.54
step  457/1000: dist 0.31 loss 3.23
step  458/1000: dist 0.31 loss 4.01
step  459/1000: dist 0.31 loss 6.42
step  460/1000: dist 0.31 loss 9.23
step  461/1000: dist 0.31 loss 10.20
step  462/1000: dist 0.31 loss 8.64
step  463/1000: dist 0.31 loss 4.75
step  464/1000: dist 0.31 loss 1.29
step  465/1000: dist 0.31 loss 1.23
step  466/1000: dist 0.31 loss 3.58
step  467/1000: dist 0.30 loss 4.88
step  468/1000: dist 0.31 loss 3.58
step  469/1000: dist 0.31 loss 1.32
step  470/1000: dist 0.31 loss 0.72
step  471/1000: dist 0.31 loss 2.10
step  472/1000: dist 0.31 loss 3.09
step  473/1000: dist 0.31 loss 2.07
step  474/1000: dist 0.31 loss 0.66
step  475/1000: dist 0.31 loss 0.85
step  476/1000: dist 0.31 loss 1.94
step  477/1000: dist 0.30 loss 2.23
```

```
step  478/1000: dist 0.30 loss 1.61
step  479/1000: dist 0.31 loss 1.47
step  480/1000: dist 0.31 loss 2.64
step  481/1000: dist 0.31 loss 4.61
step  482/1000: dist 0.31 loss 6.94
step  483/1000: dist 0.31 loss 10.78
step  484/1000: dist 0.31 loss 18.04
step  485/1000: dist 0.31 loss 29.05
step  486/1000: dist 0.31 loss 40.36
step  487/1000: dist 0.30 loss 43.49
step  488/1000: dist 0.30 loss 35.09
step  489/1000: dist 0.30 loss 29.96
step  490/1000: dist 0.31 loss 43.41
step  491/1000: dist 0.31 loss 56.04
step  492/1000: dist 0.30 loss 38.46
step  493/1000: dist 0.30 loss 8.22
step  494/1000: dist 0.30 loss 9.72
step  495/1000: dist 0.30 loss 29.15
step  496/1000: dist 0.30 loss 23.73
step  497/1000: dist 0.30 loss 7.04
step  498/1000: dist 0.30 loss 13.43
step  499/1000: dist 0.30 loss 23.59
step  500/1000: dist 0.30 loss 17.84
step  501/1000: dist 0.30 loss 19.33
step  502/1000: dist 0.30 loss 28.43
step  503/1000: dist 0.30 loss 21.12
step  504/1000: dist 0.30 loss 9.01
step  505/1000: dist 0.30 loss 8.26
step  506/1000: dist 0.30 loss 9.52
step  507/1000: dist 0.30 loss 13.00
step  508/1000: dist 0.30 loss 17.64
step  509/1000: dist 0.31 loss 14.73
step  510/1000: dist 0.30 loss 19.13
step  511/1000: dist 0.30 loss 33.71
step  512/1000: dist 0.30 loss 31.12
step  513/1000: dist 0.31 loss 13.14
step  514/1000: dist 0.30 loss 6.40
step  515/1000: dist 0.30 loss 14.30
step  516/1000: dist 0.30 loss 24.06
step  517/1000: dist 0.30 loss 24.87
step  518/1000: dist 0.30 loss 23.05
step  519/1000: dist 0.30 loss 30.82
step  520/1000: dist 0.30 loss 35.43
step  521/1000: dist 0.30 loss 30.63
step  522/1000: dist 0.30 loss 34.11
step  523/1000: dist 0.30 loss 39.74
step  524/1000: dist 0.30 loss 28.25
step  525/1000: dist 0.30 loss 11.24
```

```
step  526/1000: dist 0.30 loss 9.98
step  527/1000: dist 0.30 loss 17.81
step  528/1000: dist 0.30 loss 18.88
step  529/1000: dist 0.30 loss 12.85
step  530/1000: dist 0.30 loss 9.04
step  531/1000: dist 0.29 loss 13.49
step  532/1000: dist 0.30 loss 22.25
step  533/1000: dist 0.29 loss 28.80
step  534/1000: dist 0.30 loss 33.04
step  535/1000: dist 0.29 loss 32.25
step  536/1000: dist 0.30 loss 19.49
step  537/1000: dist 0.29 loss 6.74
step  538/1000: dist 0.29 loss 11.76
step  539/1000: dist 0.29 loss 22.10
step  540/1000: dist 0.29 loss 17.26
step  541/1000: dist 0.29 loss 13.31
step  542/1000: dist 0.29 loss 26.46
step  543/1000: dist 0.29 loss 37.41
step  544/1000: dist 0.29 loss 37.61
step  545/1000: dist 0.30 loss 35.10
step  546/1000: dist 0.29 loss 20.96
step  547/1000: dist 0.29 loss 4.67
step  548/1000: dist 0.29 loss 9.04
step  549/1000: dist 0.29 loss 18.12
step  550/1000: dist 0.29 loss 13.05
step  551/1000: dist 0.29 loss 7.97
step  552/1000: dist 0.29 loss 8.73
step  553/1000: dist 0.29 loss 7.92
step  554/1000: dist 0.29 loss 6.70
step  555/1000: dist 0.29 loss 5.97
step  556/1000: dist 0.29 loss 6.93
step  557/1000: dist 0.29 loss 7.92
step  558/1000: dist 0.29 loss 5.14
step  559/1000: dist 0.29 loss 6.64
step  560/1000: dist 0.29 loss 13.24
step  561/1000: dist 0.29 loss 15.03
step  562/1000: dist 0.29 loss 16.70
step  563/1000: dist 0.29 loss 20.20
step  564/1000: dist 0.29 loss 16.17
step  565/1000: dist 0.29 loss 11.33
step  566/1000: dist 0.29 loss 17.64
step  567/1000: dist 0.29 loss 32.97
step  568/1000: dist 0.29 loss 45.17
step  569/1000: dist 0.29 loss 35.84
step  570/1000: dist 0.29 loss 8.59
step  571/1000: dist 0.29 loss 3.59
step  572/1000: dist 0.29 loss 20.92
step  573/1000: dist 0.29 loss 20.77
```

```
step  574/1000: dist 0.29 loss 3.85
step  575/1000: dist 0.29 loss 5.55
step  576/1000: dist 0.29 loss 15.39
step  577/1000: dist 0.29 loss 7.31
step  578/1000: dist 0.29 loss 3.02
step  579/1000: dist 0.29 loss 10.18
step  580/1000: dist 0.29 loss 7.08
step  581/1000: dist 0.29 loss 5.36
step  582/1000: dist 0.29 loss 11.98
step  583/1000: dist 0.29 loss 11.95
step  584/1000: dist 0.29 loss 15.34
step  585/1000: dist 0.29 loss 22.79
step  586/1000: dist 0.29 loss 17.95
step  587/1000: dist 0.29 loss 10.92
step  588/1000: dist 0.29 loss 7.59
step  589/1000: dist 0.29 loss 6.25
step  590/1000: dist 0.29 loss 14.51
step  591/1000: dist 0.29 loss 23.03
step  592/1000: dist 0.29 loss 23.12
step  593/1000: dist 0.29 loss 22.27
step  594/1000: dist 0.29 loss 17.50
step  595/1000: dist 0.29 loss 8.61
step  596/1000: dist 0.29 loss 5.00
step  597/1000: dist 0.29 loss 7.29
step  598/1000: dist 0.29 loss 11.12
step  599/1000: dist 0.29 loss 8.93
step  600/1000: dist 0.29 loss 2.45
step  601/1000: dist 0.29 loss 3.66
step  602/1000: dist 0.29 loss 7.76
step  603/1000: dist 0.28 loss 4.72
step  604/1000: dist 0.28 loss 1.59
step  605/1000: dist 0.28 loss 3.54
step  606/1000: dist 0.29 loss 4.59
step  607/1000: dist 0.28 loss 2.44
step  608/1000: dist 0.28 loss 1.46
step  609/1000: dist 0.29 loss 2.96
step  610/1000: dist 0.28 loss 2.76
step  611/1000: dist 0.28 loss 1.17
step  612/1000: dist 0.28 loss 1.90
step  613/1000: dist 0.28 loss 2.54
step  614/1000: dist 0.28 loss 1.72
step  615/1000: dist 0.28 loss 2.48
step  616/1000: dist 0.28 loss 4.14
step  617/1000: dist 0.29 loss 5.72
step  618/1000: dist 0.28 loss 9.74
step  619/1000: dist 0.28 loss 16.44
step  620/1000: dist 0.29 loss 23.35
step  621/1000: dist 0.28 loss 26.36
```

```
step  622/1000: dist 0.28 loss 19.58
step  623/1000: dist 0.28 loss 6.19
step  624/1000: dist 0.28 loss 0.61
step  625/1000: dist 0.28 loss 7.34
step  626/1000: dist 0.28 loss 12.92
step  627/1000: dist 0.28 loss 7.42
step  628/1000: dist 0.28 loss 0.93
step  629/1000: dist 0.28 loss 4.01
step  630/1000: dist 0.28 loss 8.48
step  631/1000: dist 0.28 loss 5.70
step  632/1000: dist 0.28 loss 3.39
step  633/1000: dist 0.28 loss 8.37
step  634/1000: dist 0.28 loss 13.77
step  635/1000: dist 0.28 loss 15.47
step  636/1000: dist 0.28 loss 18.18
step  637/1000: dist 0.28 loss 18.48
step  638/1000: dist 0.28 loss 9.98
step  639/1000: dist 0.28 loss 1.43
step  640/1000: dist 0.28 loss 3.75
step  641/1000: dist 0.28 loss 10.17
step  642/1000: dist 0.28 loss 10.34
step  643/1000: dist 0.28 loss 6.58
step  644/1000: dist 0.28 loss 5.84
step  645/1000: dist 0.28 loss 9.31
step  646/1000: dist 0.28 loss 13.84
step  647/1000: dist 0.28 loss 15.09
step  648/1000: dist 0.28 loss 12.27
step  649/1000: dist 0.28 loss 9.42
step  650/1000: dist 0.28 loss 8.47
step  651/1000: dist 0.28 loss 7.07
step  652/1000: dist 0.28 loss 8.12
step  653/1000: dist 0.28 loss 16.30
step  654/1000: dist 0.28 loss 27.28
step  655/1000: dist 0.28 loss 33.61
step  656/1000: dist 0.28 loss 33.01
step  657/1000: dist 0.28 loss 26.69
step  658/1000: dist 0.28 loss 20.01
step  659/1000: dist 0.28 loss 18.61
step  660/1000: dist 0.28 loss 20.18
step  661/1000: dist 0.28 loss 18.51
step  662/1000: dist 0.28 loss 15.59
step  663/1000: dist 0.28 loss 16.57
step  664/1000: dist 0.28 loss 16.41
step  665/1000: dist 0.28 loss 9.32
step  666/1000: dist 0.28 loss 3.90
step  667/1000: dist 0.28 loss 8.53
step  668/1000: dist 0.28 loss 12.98
step  669/1000: dist 0.28 loss 7.80
```

```
step  670/1000: dist 0.28 loss 3.10
step  671/1000: dist 0.28 loss 6.64
step  672/1000: dist 0.28 loss 9.86
step  673/1000: dist 0.28 loss 8.57
step  674/1000: dist 0.28 loss 9.84
step  675/1000: dist 0.28 loss 14.81
step  676/1000: dist 0.28 loss 18.89
step  677/1000: dist 0.28 loss 20.58
step  678/1000: dist 0.28 loss 17.72
step  679/1000: dist 0.28 loss 8.93
step  680/1000: dist 0.28 loss 3.00
step  681/1000: dist 0.28 loss 4.18
step  682/1000: dist 0.27 loss 7.24
step  683/1000: dist 0.28 loss 8.75
step  684/1000: dist 0.27 loss 6.74
step  685/1000: dist 0.27 loss 2.29
step  686/1000: dist 0.28 loss 1.71
step  687/1000: dist 0.27 loss 5.19
step  688/1000: dist 0.27 loss 5.46
step  689/1000: dist 0.27 loss 2.11
step  690/1000: dist 0.27 loss 1.13
step  691/1000: dist 0.27 loss 2.81
step  692/1000: dist 0.28 loss 3.43
step  693/1000: dist 0.27 loss 2.14
step  694/1000: dist 0.28 loss 0.88
step  695/1000: dist 0.27 loss 1.39
step  696/1000: dist 0.27 loss 2.45
step  697/1000: dist 0.27 loss 1.76
step  698/1000: dist 0.27 loss 0.53
step  699/1000: dist 0.27 loss 0.99
step  700/1000: dist 0.27 loss 1.77
step  701/1000: dist 0.27 loss 1.13
step  702/1000: dist 0.27 loss 0.46
step  703/1000: dist 0.27 loss 0.87
step  704/1000: dist 0.27 loss 1.19
step  705/1000: dist 0.27 loss 0.77
step  706/1000: dist 0.27 loss 0.46
step  707/1000: dist 0.27 loss 0.65
step  708/1000: dist 0.27 loss 0.84
step  709/1000: dist 0.27 loss 0.67
step  710/1000: dist 0.27 loss 0.40
step  711/1000: dist 0.27 loss 0.47
step  712/1000: dist 0.27 loss 0.67
step  713/1000: dist 0.27 loss 0.56
step  714/1000: dist 0.27 loss 0.33
step  715/1000: dist 0.27 loss 0.40
step  716/1000: dist 0.27 loss 0.56
step  717/1000: dist 0.27 loss 0.45
```

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step  718/1000: dist 0.27 loss 0.30
step  719/1000: dist 0.27 loss 0.38
step  720/1000: dist 0.27 loss 0.47
step  721/1000: dist 0.27 loss 0.40
step  722/1000: dist 0.27 loss 0.34
step  723/1000: dist 0.27 loss 0.40
step  724/1000: dist 0.27 loss 0.48
step  725/1000: dist 0.27 loss 0.53
step  726/1000: dist 0.27 loss 0.62
step  727/1000: dist 0.27 loss 0.89
step  728/1000: dist 0.27 loss 1.42
step  729/1000: dist 0.27 loss 2.33
step  730/1000: dist 0.27 loss 3.93
step  731/1000: dist 0.27 loss 6.68
step  732/1000: dist 0.27 loss 10.94
step  733/1000: dist 0.27 loss 15.81
step  734/1000: dist 0.27 loss 18.82
step  735/1000: dist 0.27 loss 15.64
step  736/1000: dist 0.27 loss 7.32
step  737/1000: dist 0.27 loss 1.40
step  738/1000: dist 0.27 loss 3.80
step  739/1000: dist 0.27 loss 10.37
step  740/1000: dist 0.27 loss 13.10
step  741/1000: dist 0.27 loss 12.50
step  742/1000: dist 0.27 loss 16.46
step  743/1000: dist 0.27 loss 24.98
step  744/1000: dist 0.27 loss 25.68
step  745/1000: dist 0.27 loss 12.94
step  746/1000: dist 0.27 loss 1.45
step  747/1000: dist 0.27 loss 4.53
step  748/1000: dist 0.27 loss 12.64
step  749/1000: dist 0.27 loss 11.11
step  750/1000: dist 0.27 loss 4.38
step  751/1000: dist 0.27 loss 6.23
step  752/1000: dist 0.27 loss 14.54
step  753/1000: dist 0.27 loss 19.38
step  754/1000: dist 0.27 loss 24.91
step  755/1000: dist 0.27 loss 38.32
step  756/1000: dist 0.27 loss 49.84
step  757/1000: dist 0.27 loss 45.00
step  758/1000: dist 0.27 loss 26.81
step  759/1000: dist 0.27 loss 10.55
step  760/1000: dist 0.27 loss 12.87
step  761/1000: dist 0.27 loss 24.01
step  762/1000: dist 0.27 loss 19.21
step  763/1000: dist 0.27 loss 4.68
step  764/1000: dist 0.27 loss 8.19
step  765/1000: dist 0.27 loss 18.31
```

```
step   766/1000: dist 0.27 loss 10.53
step   767/1000: dist 0.27 loss 4.86
step   768/1000: dist 0.27 loss 14.35
step   769/1000: dist 0.27 loss 16.69
step   770/1000: dist 0.27 loss 14.24
step   771/1000: dist 0.27 loss 18.36
step   772/1000: dist 0.27 loss 16.86
step   773/1000: dist 0.27 loss 10.16
step   774/1000: dist 0.27 loss 5.91
step   775/1000: dist 0.27 loss 2.40
step   776/1000: dist 0.27 loss 5.78
step   777/1000: dist 0.27 loss 9.85
step   778/1000: dist 0.27 loss 5.25
step   779/1000: dist 0.27 loss 2.71
step   780/1000: dist 0.27 loss 3.53
step   781/1000: dist 0.27 loss 3.63
step   782/1000: dist 0.27 loss 4.95
step   783/1000: dist 0.27 loss 3.32
step   784/1000: dist 0.27 loss 1.88
step   785/1000: dist 0.27 loss 3.50
step   786/1000: dist 0.27 loss 3.54
step   787/1000: dist 0.27 loss 3.26
step   788/1000: dist 0.27 loss 2.55
step   789/1000: dist 0.27 loss 2.22
step   790/1000: dist 0.27 loss 3.33
step   791/1000: dist 0.27 loss 1.91
step   792/1000: dist 0.27 loss 0.82
step   793/1000: dist 0.27 loss 1.64
step   794/1000: dist 0.27 loss 1.18
step   795/1000: dist 0.27 loss 0.74
step   796/1000: dist 0.27 loss 0.89
step   797/1000: dist 0.27 loss 1.26
step   798/1000: dist 0.27 loss 1.18
step   799/1000: dist 0.27 loss 0.55
step   800/1000: dist 0.27 loss 0.84
step   801/1000: dist 0.27 loss 0.76
step   802/1000: dist 0.27 loss 0.39
step   803/1000: dist 0.27 loss 0.65
step   804/1000: dist 0.27 loss 0.71
step   805/1000: dist 0.27 loss 0.57
step   806/1000: dist 0.27 loss 0.41
step   807/1000: dist 0.27 loss 0.51
step   808/1000: dist 0.27 loss 0.46
step   809/1000: dist 0.27 loss 0.35
step   810/1000: dist 0.27 loss 0.53
step   811/1000: dist 0.27 loss 0.39
step   812/1000: dist 0.27 loss 0.33
step   813/1000: dist 0.27 loss 0.39
```

```
step  814/1000: dist 0.27 loss 0.37
step  815/1000: dist 0.27 loss 0.36
step  816/1000: dist 0.27 loss 0.33
step  817/1000: dist 0.27 loss 0.35
step  818/1000: dist 0.27 loss 0.30
step  819/1000: dist 0.27 loss 0.34
step  820/1000: dist 0.27 loss 0.33
step  821/1000: dist 0.27 loss 0.29
step  822/1000: dist 0.27 loss 0.31
step  823/1000: dist 0.27 loss 0.31
step  824/1000: dist 0.27 loss 0.30
step  825/1000: dist 0.27 loss 0.29
step  826/1000: dist 0.27 loss 0.30
step  827/1000: dist 0.27 loss 0.28
step  828/1000: dist 0.27 loss 0.29
step  829/1000: dist 0.27 loss 0.28
step  830/1000: dist 0.27 loss 0.28
step  831/1000: dist 0.27 loss 0.29
step  832/1000: dist 0.27 loss 0.27
step  833/1000: dist 0.27 loss 0.28
step  834/1000: dist 0.27 loss 0.28
step  835/1000: dist 0.27 loss 0.28
step  836/1000: dist 0.27 loss 0.27
step  837/1000: dist 0.27 loss 0.28
step  838/1000: dist 0.27 loss 0.27
step  839/1000: dist 0.27 loss 0.27
step  840/1000: dist 0.27 loss 0.27
step  841/1000: dist 0.27 loss 0.27
step  842/1000: dist 0.27 loss 0.27
step  843/1000: dist 0.27 loss 0.27
step  844/1000: dist 0.27 loss 0.27
step  845/1000: dist 0.27 loss 0.27
step  846/1000: dist 0.27 loss 0.27
step  847/1000: dist 0.27 loss 0.27
step  848/1000: dist 0.27 loss 0.27
step  849/1000: dist 0.27 loss 0.27
step  850/1000: dist 0.27 loss 0.27
step  851/1000: dist 0.27 loss 0.27
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step  853/1000: dist 0.27 loss 0.27
step  854/1000: dist 0.27 loss 0.27
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step  856/1000: dist 0.27 loss 0.27
step  857/1000: dist 0.27 loss 0.27
step  858/1000: dist 0.27 loss 0.27
step  859/1000: dist 0.27 loss 0.27
step  860/1000: dist 0.27 loss 0.27
step  861/1000: dist 0.27 loss 0.27
```

```
step   862/1000: dist 0.27 loss 0.27
step   863/1000: dist 0.27 loss 0.27
step   864/1000: dist 0.27 loss 0.27
step   865/1000: dist 0.27 loss 0.27
step   866/1000: dist 0.27 loss 0.27
step   867/1000: dist 0.27 loss 0.27
step   868/1000: dist 0.27 loss 0.27
step   869/1000: dist 0.27 loss 0.27
step   870/1000: dist 0.27 loss 0.27
step   871/1000: dist 0.27 loss 0.27
step   872/1000: dist 0.27 loss 0.27
step   873/1000: dist 0.27 loss 0.27
step   874/1000: dist 0.27 loss 0.27
step   875/1000: dist 0.27 loss 0.27
step   876/1000: dist 0.27 loss 0.27
step   877/1000: dist 0.27 loss 0.27
step   878/1000: dist 0.27 loss 0.27
step   879/1000: dist 0.27 loss 0.27
step   880/1000: dist 0.27 loss 0.27
step   881/1000: dist 0.27 loss 0.27
step   882/1000: dist 0.27 loss 0.27
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step   890/1000: dist 0.27 loss 0.27
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step   892/1000: dist 0.27 loss 0.27
step   893/1000: dist 0.27 loss 0.27
step   894/1000: dist 0.27 loss 0.27
step   895/1000: dist 0.27 loss 0.27
step   896/1000: dist 0.27 loss 0.27
step   897/1000: dist 0.27 loss 0.27
step   898/1000: dist 0.27 loss 0.27
step   899/1000: dist 0.27 loss 0.27
step   900/1000: dist 0.27 loss 0.27
step   901/1000: dist 0.27 loss 0.27
step   902/1000: dist 0.27 loss 0.27
step   903/1000: dist 0.27 loss 0.27
step   904/1000: dist 0.27 loss 0.27
step   905/1000: dist 0.27 loss 0.27
step   906/1000: dist 0.27 loss 0.27
step   907/1000: dist 0.26 loss 0.26
step   908/1000: dist 0.26 loss 0.26
step   909/1000: dist 0.26 loss 0.26
```

```
step  910/1000: dist 0.26 loss 0.26
step  911/1000: dist 0.26 loss 0.26
step  912/1000: dist 0.26 loss 0.26
step  913/1000: dist 0.26 loss 0.26
step  914/1000: dist 0.26 loss 0.26
step  915/1000: dist 0.26 loss 0.26
step  916/1000: dist 0.26 loss 0.26
step  917/1000: dist 0.26 loss 0.26
step  918/1000: dist 0.26 loss 0.26
step  919/1000: dist 0.26 loss 0.26
step  920/1000: dist 0.26 loss 0.26
step  921/1000: dist 0.26 loss 0.26
step  922/1000: dist 0.26 loss 0.26
step  923/1000: dist 0.26 loss 0.26
step  924/1000: dist 0.26 loss 0.26
step  925/1000: dist 0.26 loss 0.26
step  926/1000: dist 0.26 loss 0.26
step  927/1000: dist 0.26 loss 0.26
step  928/1000: dist 0.26 loss 0.26
step  929/1000: dist 0.26 loss 0.26
step  930/1000: dist 0.26 loss 0.26
step  931/1000: dist 0.26 loss 0.26
step  932/1000: dist 0.26 loss 0.26
step  933/1000: dist 0.26 loss 0.26
step  934/1000: dist 0.26 loss 0.26
step  935/1000: dist 0.26 loss 0.26
step  936/1000: dist 0.26 loss 0.26
step  937/1000: dist 0.26 loss 0.26
step  938/1000: dist 0.26 loss 0.26
step  939/1000: dist 0.26 loss 0.26
step  940/1000: dist 0.26 loss 0.26
step  941/1000: dist 0.26 loss 0.26
step  942/1000: dist 0.26 loss 0.26
step  943/1000: dist 0.26 loss 0.26
step  944/1000: dist 0.26 loss 0.26
step  945/1000: dist 0.26 loss 0.26
step  946/1000: dist 0.26 loss 0.26
step  947/1000: dist 0.26 loss 0.26
step  948/1000: dist 0.26 loss 0.26
step  949/1000: dist 0.26 loss 0.26
step  950/1000: dist 0.26 loss 0.26
step  951/1000: dist 0.26 loss 0.26
step  952/1000: dist 0.26 loss 0.26
step  953/1000: dist 0.26 loss 0.26
step  954/1000: dist 0.26 loss 0.26
step  955/1000: dist 0.26 loss 0.26
step  956/1000: dist 0.26 loss 0.26
step  957/1000: dist 0.26 loss 0.26
```

```
step  958/1000: dist 0.26 loss 0.26
step  959/1000: dist 0.26 loss 0.26
step  960/1000: dist 0.26 loss 0.26
step  961/1000: dist 0.26 loss 0.26
step  962/1000: dist 0.26 loss 0.26
step  963/1000: dist 0.26 loss 0.26
step  964/1000: dist 0.26 loss 0.26
step  965/1000: dist 0.26 loss 0.26
step  966/1000: dist 0.26 loss 0.26
step  967/1000: dist 0.26 loss 0.26
step  968/1000: dist 0.26 loss 0.26
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step  970/1000: dist 0.26 loss 0.26
step  971/1000: dist 0.26 loss 0.26
step  972/1000: dist 0.26 loss 0.26
step  973/1000: dist 0.26 loss 0.26
step  974/1000: dist 0.26 loss 0.26
step  975/1000: dist 0.26 loss 0.26
step  976/1000: dist 0.26 loss 0.26
step  977/1000: dist 0.26 loss 0.26
step  978/1000: dist 0.26 loss 0.26
step  979/1000: dist 0.26 loss 0.26
step  980/1000: dist 0.26 loss 0.26
step  981/1000: dist 0.26 loss 0.26
step  982/1000: dist 0.26 loss 0.26
step  983/1000: dist 0.26 loss 0.26
step  984/1000: dist 0.26 loss 0.26
step  985/1000: dist 0.26 loss 0.26
step  986/1000: dist 0.26 loss 0.26
step  987/1000: dist 0.26 loss 0.26
step  988/1000: dist 0.26 loss 0.26
step  989/1000: dist 0.26 loss 0.26
step  990/1000: dist 0.26 loss 0.26
step  991/1000: dist 0.26 loss 0.26
step  992/1000: dist 0.26 loss 0.26
step  993/1000: dist 0.26 loss 0.26
step  994/1000: dist 0.26 loss 0.26
step  995/1000: dist 0.26 loss 0.26
step  996/1000: dist 0.26 loss 0.26
step  997/1000: dist 0.26 loss 0.26
step  998/1000: dist 0.26 loss 0.26
step  999/1000: dist 0.26 loss 0.26
step 1000/1000: dist 0.26 loss 0.26
Elapsed: 121.4 s
```

4.6   Convert Target to a GAN

Next, we convert the target to a GAN latent vector. This process will also take several minutes.

```
# HIDE OUTPUT
cmd = f"python /content/stylegan2-ada-pytorch/projector.py "\
  f"--save-video 0 --num-steps 1000 --outdir=out_target "\
  f"--target=cropped_target.png --network={NETWORK}"
!{cmd}
```

Loading networks from "https://nvlabs-fi-cdn.nvidia.com/stylegan2-ada-pytorch/pretrained/ffhq.pkl"…
Computing W midpoint and stddev using 10000 samples…
Setting up PyTorch plugin "bias_act_plugin"… Done.
Setting up PyTorch plugin "upfirdn2d_plugin"… Done.
step   1/1000: dist 0.63 loss 24568.77
step   2/1000: dist 0.60 loss 27642.11
step   3/1000: dist 0.60 loss 27167.12
step   4/1000: dist 0.57 loss 26253.35
step   5/1000: dist 0.61 loss 24959.81
step   6/1000: dist 0.60 loss 23356.12
step   7/1000: dist 0.56 loss 21512.13
step   8/1000: dist 0.59 loss 19487.23
step   9/1000: dist 0.55 loss 17341.27
step   10/1000: dist 0.56 loss 15140.35
step   11/1000: dist 0.63 loss 12949.49
step   12/1000: dist 0.55 loss 10820.17
step   13/1000: dist 0.56 loss 8802.83
step   14/1000: dist 0.61 loss 6946.22
step   15/1000: dist 0.58 loss 5316.71
step   16/1000: dist 0.52 loss 3971.15
step   17/1000: dist 0.55 loss 2941.10
step   18/1000: dist 0.50 loss 2216.22
step   19/1000: dist 0.51 loss 1758.78
step   20/1000: dist 0.52 loss 1567.52
step   21/1000: dist 0.51 loss 1602.28
step   22/1000: dist 0.49 loss 1787.82
step   23/1000: dist 0.48 loss 2053.34
step   24/1000: dist 0.48 loss 2327.56
step   25/1000: dist 0.48 loss 2538.77
step   26/1000: dist 0.48 loss 2637.36
step   27/1000: dist 0.49 loss 2604.07
step   28/1000: dist 0.49 loss 2477.09
step   29/1000: dist 0.51 loss 2317.29
step   30/1000: dist 0.48 loss 2120.27
step   31/1000: dist 0.47 loss 1884.58
step   32/1000: dist 0.50 loss 1627.86
step   33/1000: dist 0.48 loss 1388.84
step   34/1000: dist 0.45 loss 1183.89
step   35/1000: dist 0.45 loss 1026.39
step   36/1000: dist 0.45 loss 909.69
step   37/1000: dist 0.46 loss 830.82
```

```
step    38/1000: dist 0.48 loss 805.27
step    39/1000: dist 0.45 loss 812.57
step    40/1000: dist 0.45 loss 834.66
step    41/1000: dist 0.47 loss 828.71
step    42/1000: dist 0.47 loss 761.27
step    43/1000: dist 0.49 loss 651.15
step    44/1000: dist 0.49 loss 521.39
step    45/1000: dist 0.46 loss 402.71
step    46/1000: dist 0.47 loss 318.35
step    47/1000: dist 0.49 loss 263.81
step    48/1000: dist 0.48 loss 241.38
step    49/1000: dist 0.47 loss 251.26
step    50/1000: dist 0.46 loss 304.01
step    51/1000: dist 0.44 loss 369.49
step    52/1000: dist 0.45 loss 401.52
step    53/1000: dist 0.46 loss 400.59
step    54/1000: dist 0.46 loss 369.86
step    55/1000: dist 0.46 loss 282.55
step    56/1000: dist 0.45 loss 201.64
step    57/1000: dist 0.45 loss 149.67
step    58/1000: dist 0.47 loss 80.04
step    59/1000: dist 0.48 loss 60.75
step    60/1000: dist 0.46 loss 60.34
step    61/1000: dist 0.45 loss 62.42
step    62/1000: dist 0.42 loss 95.78
step    63/1000: dist 0.45 loss 108.14
step    64/1000: dist 0.43 loss 133.23
step    65/1000: dist 0.43 loss 133.46
step    66/1000: dist 0.44 loss 115.09
step    67/1000: dist 0.43 loss 106.48
step    68/1000: dist 0.43 loss 71.30
step    69/1000: dist 0.45 loss 49.85
step    70/1000: dist 0.43 loss 29.17
step    71/1000: dist 0.44 loss 20.93
step    72/1000: dist 0.44 loss 18.21
step    73/1000: dist 0.42 loss 20.99
step    74/1000: dist 0.43 loss 30.88
step    75/1000: dist 0.45 loss 32.53
step    76/1000: dist 0.45 loss 40.11
step    77/1000: dist 0.45 loss 37.00
step    78/1000: dist 0.44 loss 32.15
step    79/1000: dist 0.41 loss 30.82
step    80/1000: dist 0.42 loss 27.17
step    81/1000: dist 0.41 loss 22.75
step    82/1000: dist 0.42 loss 13.63
step    83/1000: dist 0.42 loss 13.14
step    84/1000: dist 0.41 loss 15.89
step    85/1000: dist 0.40 loss 15.54
```

```
step    86/1000: dist 0.42 loss 12.85
step    87/1000: dist 0.42 loss 10.69
step    88/1000: dist 0.44 loss 11.77
step    89/1000: dist 0.41 loss 10.23
step    90/1000: dist 0.41 loss 7.86
step    91/1000: dist 0.42 loss 6.77
step    92/1000: dist 0.41 loss 6.25
step    93/1000: dist 0.41 loss 7.11
step    94/1000: dist 0.41 loss 8.53
step    95/1000: dist 0.40 loss 10.37
step    96/1000: dist 0.41 loss 11.90
step    97/1000: dist 0.41 loss 11.11
step    98/1000: dist 0.41 loss 7.58
step    99/1000: dist 0.41 loss 3.91
step   100/1000: dist 0.40 loss 3.10
step   101/1000: dist 0.40 loss 4.27
step   102/1000: dist 0.40 loss 4.44
step   103/1000: dist 0.41 loss 2.91
step   104/1000: dist 0.44 loss 2.21
step   105/1000: dist 0.40 loss 3.64
step   106/1000: dist 0.42 loss 5.15
step   107/1000: dist 0.42 loss 5.45
step   108/1000: dist 0.41 loss 5.54
step   109/1000: dist 0.42 loss 5.72
step   110/1000: dist 0.40 loss 5.34
step   111/1000: dist 0.40 loss 4.88
step   112/1000: dist 0.39 loss 6.34
step   113/1000: dist 0.40 loss 10.53
step   114/1000: dist 0.41 loss 14.98
step   115/1000: dist 0.41 loss 14.98
step   116/1000: dist 0.42 loss 9.25
step   117/1000: dist 0.40 loss 5.78
step   118/1000: dist 0.42 loss 9.34
step   119/1000: dist 0.41 loss 12.45
step   120/1000: dist 0.42 loss 10.44
step   121/1000: dist 0.41 loss 11.29
step   122/1000: dist 0.41 loss 16.97
step   123/1000: dist 0.41 loss 13.82
step   124/1000: dist 0.40 loss 3.49
step   125/1000: dist 0.40 loss 4.26
step   126/1000: dist 0.40 loss 12.04
step   127/1000: dist 0.40 loss 9.42
step   128/1000: dist 0.39 loss 2.48
step   129/1000: dist 0.42 loss 5.23
step   130/1000: dist 0.40 loss 8.20
step   131/1000: dist 0.42 loss 3.68
step   132/1000: dist 0.40 loss 2.79
step   133/1000: dist 0.39 loss 6.47
```

```
step  134/1000: dist 0.39 loss 5.09
step  135/1000: dist 0.42 loss 3.70
step  136/1000: dist 0.39 loss 8.50
step  137/1000: dist 0.39 loss 13.20
step  138/1000: dist 0.39 loss 15.67
step  139/1000: dist 0.39 loss 15.73
step  140/1000: dist 0.39 loss 10.51
step  141/1000: dist 0.39 loss 8.84
step  142/1000: dist 0.39 loss 15.89
step  143/1000: dist 0.40 loss 17.21
step  144/1000: dist 0.38 loss 8.13
step  145/1000: dist 0.40 loss 7.21
step  146/1000: dist 0.39 loss 15.88
step  147/1000: dist 0.41 loss 16.82
step  148/1000: dist 0.40 loss 10.13
step  149/1000: dist 0.39 loss 6.30
step  150/1000: dist 0.39 loss 4.91
step  151/1000: dist 0.40 loss 5.57
step  152/1000: dist 0.40 loss 9.53
step  153/1000: dist 0.39 loss 9.50
step  154/1000: dist 0.39 loss 5.56
step  155/1000: dist 0.38 loss 8.20
step  156/1000: dist 0.39 loss 14.62
step  157/1000: dist 0.39 loss 13.69
step  158/1000: dist 0.39 loss 7.50
step  159/1000: dist 0.38 loss 4.26
step  160/1000: dist 0.40 loss 5.56
step  161/1000: dist 0.39 loss 9.38
step  162/1000: dist 0.40 loss 13.38
step  163/1000: dist 0.42 loss 16.43
step  164/1000: dist 0.39 loss 22.84
step  165/1000: dist 0.39 loss 35.32
step  166/1000: dist 0.38 loss 38.83
step  167/1000: dist 0.38 loss 17.69
step  168/1000: dist 0.40 loss 7.40
step  169/1000: dist 0.40 loss 23.03
step  170/1000: dist 0.41 loss 17.91
step  171/1000: dist 0.40 loss 3.20
step  172/1000: dist 0.40 loss 13.44
step  173/1000: dist 0.40 loss 13.49
step  174/1000: dist 0.39 loss 7.86
step  175/1000: dist 0.39 loss 14.67
step  176/1000: dist 0.39 loss 9.40
step  177/1000: dist 0.39 loss 10.84
step  178/1000: dist 0.38 loss 16.66
step  179/1000: dist 0.39 loss 8.86
step  180/1000: dist 0.38 loss 8.32
step  181/1000: dist 0.39 loss 6.36
```

```
step   182/1000: dist 0.39 loss 5.12
step   183/1000: dist 0.39 loss 10.92
step   184/1000: dist 0.39 loss 10.32
step   185/1000: dist 0.39 loss 13.67
step   186/1000: dist 0.39 loss 15.94
step   187/1000: dist 0.39 loss 13.11
step   188/1000: dist 0.39 loss 11.61
step   189/1000: dist 0.39 loss 8.15
step   190/1000: dist 0.38 loss 10.88
step   191/1000: dist 0.40 loss 13.93
step   192/1000: dist 0.38 loss 11.13
step   193/1000: dist 0.37 loss 10.81
step   194/1000: dist 0.37 loss 15.03
step   195/1000: dist 0.38 loss 25.86
step   196/1000: dist 0.39 loss 37.01
step   197/1000: dist 0.38 loss 37.96
step   198/1000: dist 0.39 loss 21.87
step   199/1000: dist 0.38 loss 7.17
step   200/1000: dist 0.39 loss 14.34
step   201/1000: dist 0.38 loss 19.18
step   202/1000: dist 0.38 loss 9.69
step   203/1000: dist 0.38 loss 10.58
step   204/1000: dist 0.38 loss 12.80
step   205/1000: dist 0.38 loss 4.86
step   206/1000: dist 0.38 loss 7.54
step   207/1000: dist 0.37 loss 11.50
step   208/1000: dist 0.38 loss 3.47
step   209/1000: dist 0.37 loss 4.03
step   210/1000: dist 0.37 loss 8.23
step   211/1000: dist 0.37 loss 3.73
step   212/1000: dist 0.37 loss 3.60
step   213/1000: dist 0.37 loss 4.48
step   214/1000: dist 0.37 loss 2.89
step   215/1000: dist 0.38 loss 4.53
step   216/1000: dist 0.37 loss 2.58
step   217/1000: dist 0.37 loss 1.50
step   218/1000: dist 0.37 loss 4.20
step   219/1000: dist 0.38 loss 2.48
step   220/1000: dist 0.38 loss 1.55
step   221/1000: dist 0.37 loss 2.85
step   222/1000: dist 0.38 loss 2.44
step   223/1000: dist 0.37 loss 3.21
step   224/1000: dist 0.38 loss 3.23
step   225/1000: dist 0.38 loss 3.19
step   226/1000: dist 0.38 loss 5.29
step   227/1000: dist 0.37 loss 5.61
step   228/1000: dist 0.38 loss 5.14
step   229/1000: dist 0.38 loss 4.79
```

```
step  230/1000: dist 0.37 loss 2.85
step  231/1000: dist 0.37 loss 1.50
step  232/1000: dist 0.37 loss 1.02
step  233/1000: dist 0.38 loss 1.11
step  234/1000: dist 0.37 loss 2.43
step  235/1000: dist 0.38 loss 2.87
step  236/1000: dist 0.37 loss 2.11
step  237/1000: dist 0.37 loss 1.41
step  238/1000: dist 0.37 loss 0.73
step  239/1000: dist 0.37 loss 0.76
step  240/1000: dist 0.36 loss 1.32
step  241/1000: dist 0.37 loss 1.43
step  242/1000: dist 0.37 loss 1.41
step  243/1000: dist 0.37 loss 1.16
step  244/1000: dist 0.36 loss 0.65
step  245/1000: dist 0.36 loss 0.58
step  246/1000: dist 0.37 loss 0.78
step  247/1000: dist 0.37 loss 1.00
step  248/1000: dist 0.38 loss 1.29
step  249/1000: dist 0.38 loss 1.37
step  250/1000: dist 0.39 loss 1.63
step  251/1000: dist 0.36 loss 2.78
step  252/1000: dist 0.37 loss 5.55
step  253/1000: dist 0.37 loss 10.95
step  254/1000: dist 0.36 loss 18.49
step  255/1000: dist 0.36 loss 21.99
step  256/1000: dist 0.36 loss 13.80
step  257/1000: dist 0.37 loss 3.10
step  258/1000: dist 0.37 loss 6.43
step  259/1000: dist 0.36 loss 16.95
step  260/1000: dist 0.37 loss 18.68
step  261/1000: dist 0.36 loss 19.48
step  262/1000: dist 0.35 loss 31.48
step  263/1000: dist 0.38 loss 37.36
step  264/1000: dist 0.36 loss 25.85
step  265/1000: dist 0.36 loss 16.00
step  266/1000: dist 0.36 loss 17.50
step  267/1000: dist 0.36 loss 19.14
step  268/1000: dist 0.37 loss 16.35
step  269/1000: dist 0.36 loss 10.63
step  270/1000: dist 0.35 loss 5.18
step  271/1000: dist 0.36 loss 8.53
step  272/1000: dist 0.36 loss 13.82
step  273/1000: dist 0.36 loss 8.40
step  274/1000: dist 0.35 loss 3.64
step  275/1000: dist 0.37 loss 8.15
step  276/1000: dist 0.36 loss 9.72
step  277/1000: dist 0.37 loss 8.79
```

```
step  278/1000: dist 0.36 loss 14.53
step  279/1000: dist 0.35 loss 19.90
step  280/1000: dist 0.35 loss 18.01
step  281/1000: dist 0.36 loss 12.53
step  282/1000: dist 0.36 loss 7.74
step  283/1000: dist 0.36 loss 7.64
step  284/1000: dist 0.35 loss 14.28
step  285/1000: dist 0.36 loss 22.87
step  286/1000: dist 0.35 loss 30.05
step  287/1000: dist 0.35 loss 42.14
step  288/1000: dist 0.36 loss 57.32
step  289/1000: dist 0.37 loss 58.00
step  290/1000: dist 0.37 loss 40.22
step  291/1000: dist 0.36 loss 29.92
step  292/1000: dist 0.36 loss 37.92
step  293/1000: dist 0.36 loss 39.55
step  294/1000: dist 0.35 loss 24.88
step  295/1000: dist 0.35 loss 19.24
step  296/1000: dist 0.36 loss 29.04
step  297/1000: dist 0.35 loss 28.44
step  298/1000: dist 0.35 loss 14.75
step  299/1000: dist 0.36 loss 13.28
step  300/1000: dist 0.35 loss 23.15
step  301/1000: dist 0.36 loss 21.66
step  302/1000: dist 0.36 loss 11.28
step  303/1000: dist 0.36 loss 8.81
step  304/1000: dist 0.36 loss 10.64
step  305/1000: dist 0.37 loss 8.16
step  306/1000: dist 0.35 loss 7.31
step  307/1000: dist 0.36 loss 10.09
step  308/1000: dist 0.35 loss 8.90
step  309/1000: dist 0.35 loss 4.98
step  310/1000: dist 0.35 loss 4.78
step  311/1000: dist 0.35 loss 6.37
step  312/1000: dist 0.35 loss 6.58
step  313/1000: dist 0.35 loss 7.24
step  314/1000: dist 0.35 loss 9.44
step  315/1000: dist 0.35 loss 13.21
step  316/1000: dist 0.35 loss 18.81
step  317/1000: dist 0.35 loss 21.85
step  318/1000: dist 0.35 loss 18.14
step  319/1000: dist 0.35 loss 11.98
step  320/1000: dist 0.35 loss 11.39
step  321/1000: dist 0.36 loss 14.91
step  322/1000: dist 0.35 loss 15.84
step  323/1000: dist 0.36 loss 11.16
step  324/1000: dist 0.35 loss 5.78
step  325/1000: dist 0.35 loss 6.52
```

```
step  326/1000: dist 0.36 loss 9.82
step  327/1000: dist 0.35 loss 8.05
step  328/1000: dist 0.35 loss 3.55
step  329/1000: dist 0.36 loss 3.58
step  330/1000: dist 0.35 loss 6.34
step  331/1000: dist 0.34 loss 5.66
step  332/1000: dist 0.35 loss 2.97
step  333/1000: dist 0.35 loss 2.66
step  334/1000: dist 0.35 loss 3.64
step  335/1000: dist 0.35 loss 3.52
step  336/1000: dist 0.35 loss 3.05
step  337/1000: dist 0.35 loss 2.88
step  338/1000: dist 0.35 loss 2.95
step  339/1000: dist 0.35 loss 4.19
step  340/1000: dist 0.34 loss 6.59
step  341/1000: dist 0.35 loss 9.43
step  342/1000: dist 0.35 loss 13.87
step  343/1000: dist 0.34 loss 20.12
step  344/1000: dist 0.35 loss 23.36
step  345/1000: dist 0.34 loss 20.32
step  346/1000: dist 0.35 loss 16.37
step  347/1000: dist 0.35 loss 16.01
step  348/1000: dist 0.34 loss 13.92
step  349/1000: dist 0.34 loss 8.05
step  350/1000: dist 0.34 loss 4.54
step  351/1000: dist 0.34 loss 7.58
step  352/1000: dist 0.34 loss 10.71
step  353/1000: dist 0.35 loss 7.02
step  354/1000: dist 0.34 loss 2.61
step  355/1000: dist 0.34 loss 5.11
step  356/1000: dist 0.34 loss 9.35
step  357/1000: dist 0.34 loss 8.74
step  358/1000: dist 0.34 loss 9.35
step  359/1000: dist 0.34 loss 17.84
step  360/1000: dist 0.34 loss 25.91
step  361/1000: dist 0.34 loss 22.36
step  362/1000: dist 0.34 loss 9.73
step  363/1000: dist 0.34 loss 3.08
step  364/1000: dist 0.34 loss 7.06
step  365/1000: dist 0.34 loss 11.71
step  366/1000: dist 0.33 loss 9.02
step  367/1000: dist 0.34 loss 3.32
step  368/1000: dist 0.34 loss 3.70
step  369/1000: dist 0.34 loss 7.23
step  370/1000: dist 0.34 loss 5.62
step  371/1000: dist 0.34 loss 2.02
step  372/1000: dist 0.34 loss 3.21
step  373/1000: dist 0.33 loss 4.99
```

```
step   374/1000: dist 0.34 loss 2.75
step   375/1000: dist 0.34 loss 1.43
step   376/1000: dist 0.33 loss 3.18
step   377/1000: dist 0.34 loss 3.04
step   378/1000: dist 0.33 loss 1.30
step   379/1000: dist 0.34 loss 2.00
step   380/1000: dist 0.34 loss 3.04
step   381/1000: dist 0.34 loss 2.39
step   382/1000: dist 0.34 loss 3.30
step   383/1000: dist 0.33 loss 6.57
step   384/1000: dist 0.34 loss 10.44
step   385/1000: dist 0.35 loss 16.30
step   386/1000: dist 0.35 loss 22.44
step   387/1000: dist 0.34 loss 20.03
step   388/1000: dist 0.34 loss 7.82
step   389/1000: dist 0.34 loss 0.80
step   390/1000: dist 0.34 loss 5.98
step   391/1000: dist 0.34 loss 11.64
step   392/1000: dist 0.35 loss 7.74
step   393/1000: dist 0.34 loss 1.41
step   394/1000: dist 0.33 loss 3.10
step   395/1000: dist 0.33 loss 7.24
step   396/1000: dist 0.34 loss 4.74
step   397/1000: dist 0.34 loss 0.86
step   398/1000: dist 0.34 loss 2.83
step   399/1000: dist 0.33 loss 4.92
step   400/1000: dist 0.34 loss 2.22
step   401/1000: dist 0.34 loss 0.73
step   402/1000: dist 0.34 loss 2.93
step   403/1000: dist 0.35 loss 3.00
step   404/1000: dist 0.35 loss 0.81
step   405/1000: dist 0.33 loss 1.24
step   406/1000: dist 0.33 loss 2.59
step   407/1000: dist 0.33 loss 1.49
step   408/1000: dist 0.34 loss 0.74
step   409/1000: dist 0.34 loss 2.00
step   410/1000: dist 0.34 loss 2.39
step   411/1000: dist 0.34 loss 1.92
step   412/1000: dist 0.33 loss 3.25
step   413/1000: dist 0.34 loss 5.71
step   414/1000: dist 0.34 loss 7.95
step   415/1000: dist 0.34 loss 11.13
step   416/1000: dist 0.34 loss 14.47
step   417/1000: dist 0.33 loss 13.91
step   418/1000: dist 0.33 loss 9.14
step   419/1000: dist 0.33 loss 5.72
step   420/1000: dist 0.33 loss 7.88
step   421/1000: dist 0.33 loss 13.35
```

```
step  422/1000: dist 0.34 loss 15.98
step  423/1000: dist 0.34 loss 11.85
step  424/1000: dist 0.34 loss 4.34
step  425/1000: dist 0.34 loss 1.30
step  426/1000: dist 0.33 loss 4.18
step  427/1000: dist 0.33 loss 7.01
step  428/1000: dist 0.33 loss 5.81
step  429/1000: dist 0.35 loss 3.10
step  430/1000: dist 0.33 loss 2.29
step  431/1000: dist 0.33 loss 3.03
step  432/1000: dist 0.33 loss 3.42
step  433/1000: dist 0.33 loss 3.30
step  434/1000: dist 0.33 loss 3.13
step  435/1000: dist 0.33 loss 3.17
step  436/1000: dist 0.33 loss 3.97
step  437/1000: dist 0.33 loss 6.23
step  438/1000: dist 0.33 loss 9.71
step  439/1000: dist 0.33 loss 13.88
step  440/1000: dist 0.33 loss 18.35
step  441/1000: dist 0.33 loss 20.96
step  442/1000: dist 0.33 loss 18.03
step  443/1000: dist 0.33 loss 10.45
step  444/1000: dist 0.33 loss 4.76
step  445/1000: dist 0.34 loss 5.05
step  446/1000: dist 0.33 loss 7.73
step  447/1000: dist 0.33 loss 7.25
step  448/1000: dist 0.32 loss 4.44
step  449/1000: dist 0.33 loss 4.04
step  450/1000: dist 0.32 loss 5.65
step  451/1000: dist 0.33 loss 5.03
step  452/1000: dist 0.33 loss 2.42
step  453/1000: dist 0.32 loss 2.29
step  454/1000: dist 0.33 loss 5.08
step  455/1000: dist 0.32 loss 6.55
step  456/1000: dist 0.32 loss 6.01
step  457/1000: dist 0.33 loss 7.84
step  458/1000: dist 0.32 loss 13.89
step  459/1000: dist 0.32 loss 19.44
step  460/1000: dist 0.32 loss 18.82
step  461/1000: dist 0.32 loss 11.18
step  462/1000: dist 0.33 loss 3.96
step  463/1000: dist 0.32 loss 4.37
step  464/1000: dist 0.32 loss 10.30
step  465/1000: dist 0.32 loss 13.48
step  466/1000: dist 0.32 loss 10.60
step  467/1000: dist 0.32 loss 8.22
step  468/1000: dist 0.32 loss 10.44
step  469/1000: dist 0.32 loss 11.50
```

```
step  470/1000: dist 0.32 loss 6.87
step  471/1000: dist 0.33 loss 2.77
step  472/1000: dist 0.32 loss 5.52
step  473/1000: dist 0.32 loss 11.72
step  474/1000: dist 0.32 loss 17.15
step  475/1000: dist 0.32 loss 23.26
step  476/1000: dist 0.32 loss 27.49
step  477/1000: dist 0.32 loss 19.85
step  478/1000: dist 0.32 loss 5.23
step  479/1000: dist 0.33 loss 2.14
step  480/1000: dist 0.32 loss 11.52
step  481/1000: dist 0.32 loss 14.64
step  482/1000: dist 0.32 loss 5.63
step  483/1000: dist 0.32 loss 1.35
step  484/1000: dist 0.32 loss 7.80
step  485/1000: dist 0.32 loss 10.81
step  486/1000: dist 0.33 loss 7.70
step  487/1000: dist 0.33 loss 11.75
step  488/1000: dist 0.32 loss 23.55
step  489/1000: dist 0.32 loss 30.50
step  490/1000: dist 0.32 loss 26.71
step  491/1000: dist 0.33 loss 14.44
step  492/1000: dist 0.32 loss 4.90
step  493/1000: dist 0.32 loss 9.22
step  494/1000: dist 0.32 loss 17.97
step  495/1000: dist 0.32 loss 15.02
step  496/1000: dist 0.32 loss 12.14
step  497/1000: dist 0.32 loss 25.29
step  498/1000: dist 0.31 loss 37.94
step  499/1000: dist 0.31 loss 37.77
step  500/1000: dist 0.32 loss 34.20
step  501/1000: dist 0.32 loss 22.55
step  502/1000: dist 0.32 loss 8.23
step  503/1000: dist 0.32 loss 17.44
step  504/1000: dist 0.32 loss 37.55
step  505/1000: dist 0.31 loss 39.15
step  506/1000: dist 0.32 loss 38.22
step  507/1000: dist 0.32 loss 38.50
step  508/1000: dist 0.32 loss 19.56
step  509/1000: dist 0.32 loss 7.97
step  510/1000: dist 0.32 loss 22.48
step  511/1000: dist 0.32 loss 23.17
step  512/1000: dist 0.32 loss 7.87
step  513/1000: dist 0.32 loss 15.68
step  514/1000: dist 0.32 loss 23.92
step  515/1000: dist 0.32 loss 15.09
step  516/1000: dist 0.32 loss 22.75
step  517/1000: dist 0.32 loss 31.83
```

```
step  518/1000: dist 0.31 loss 22.17
step  519/1000: dist 0.31 loss 22.18
step  520/1000: dist 0.31 loss 26.55
step  521/1000: dist 0.31 loss 22.81
step  522/1000: dist 0.32 loss 24.71
step  523/1000: dist 0.31 loss 23.00
step  524/1000: dist 0.31 loss 21.71
step  525/1000: dist 0.31 loss 29.47
step  526/1000: dist 0.31 loss 26.77
step  527/1000: dist 0.31 loss 14.91
step  528/1000: dist 0.32 loss 8.91
step  529/1000: dist 0.32 loss 13.27
step  530/1000: dist 0.31 loss 26.22
step  531/1000: dist 0.31 loss 31.21
step  532/1000: dist 0.31 loss 27.09
step  533/1000: dist 0.31 loss 23.98
step  534/1000: dist 0.31 loss 17.37
step  535/1000: dist 0.31 loss 11.66
step  536/1000: dist 0.31 loss 14.19
step  537/1000: dist 0.31 loss 23.17
step  538/1000: dist 0.31 loss 32.38
step  539/1000: dist 0.31 loss 37.40
step  540/1000: dist 0.31 loss 39.18
step  541/1000: dist 0.31 loss 27.70
step  542/1000: dist 0.31 loss 10.29
step  543/1000: dist 0.31 loss 15.83
step  544/1000: dist 0.31 loss 30.35
step  545/1000: dist 0.31 loss 24.29
step  546/1000: dist 0.31 loss 14.30
step  547/1000: dist 0.32 loss 20.68
step  548/1000: dist 0.31 loss 19.18
step  549/1000: dist 0.31 loss 4.18
step  550/1000: dist 0.31 loss 5.86
step  551/1000: dist 0.32 loss 13.53
step  552/1000: dist 0.31 loss 7.49
step  553/1000: dist 0.31 loss 7.37
step  554/1000: dist 0.31 loss 10.44
step  555/1000: dist 0.31 loss 3.34
step  556/1000: dist 0.32 loss 3.55
step  557/1000: dist 0.31 loss 9.78
step  558/1000: dist 0.32 loss 7.77
step  559/1000: dist 0.32 loss 8.57
step  560/1000: dist 0.31 loss 14.80
step  561/1000: dist 0.31 loss 18.29
step  562/1000: dist 0.31 loss 22.51
step  563/1000: dist 0.32 loss 21.73
step  564/1000: dist 0.32 loss 9.16
step  565/1000: dist 0.31 loss 1.69
```

```
step   566/1000: dist 0.31 loss 6.20
step   567/1000: dist 0.31 loss 11.43
step   568/1000: dist 0.32 loss 11.19
step   569/1000: dist 0.31 loss 6.65
step   570/1000: dist 0.31 loss 7.06
step   571/1000: dist 0.31 loss 15.96
step   572/1000: dist 0.31 loss 21.67
step   573/1000: dist 0.32 loss 20.10
step   574/1000: dist 0.32 loss 17.21
step   575/1000: dist 0.31 loss 11.33
step   576/1000: dist 0.31 loss 4.11
step   577/1000: dist 0.32 loss 4.67
step   578/1000: dist 0.31 loss 11.42
step   579/1000: dist 0.32 loss 12.86
step   580/1000: dist 0.33 loss 7.76
step   581/1000: dist 0.32 loss 7.98
step   582/1000: dist 0.32 loss 15.19
step   583/1000: dist 0.32 loss 16.73
step   584/1000: dist 0.32 loss 9.93
step   585/1000: dist 0.32 loss 5.47
step   586/1000: dist 0.32 loss 5.21
step   587/1000: dist 0.32 loss 3.95
step   588/1000: dist 0.31 loss 3.71
step   589/1000: dist 0.31 loss 6.76
step   590/1000: dist 0.31 loss 7.78
step   591/1000: dist 0.31 loss 4.75
step   592/1000: dist 0.31 loss 4.03
step   593/1000: dist 0.31 loss 8.56
step   594/1000: dist 0.31 loss 13.80
step   595/1000: dist 0.31 loss 16.86
step   596/1000: dist 0.31 loss 18.13
step   597/1000: dist 0.30 loss 14.87
step   598/1000: dist 0.31 loss 7.32
step   599/1000: dist 0.31 loss 2.98
step   600/1000: dist 0.31 loss 5.80
step   601/1000: dist 0.31 loss 10.04
step   602/1000: dist 0.31 loss 10.01
step   603/1000: dist 0.31 loss 7.76
step   604/1000: dist 0.31 loss 9.13
step   605/1000: dist 0.31 loss 14.98
step   606/1000: dist 0.30 loss 19.76
step   607/1000: dist 0.31 loss 18.18
step   608/1000: dist 0.31 loss 11.99
step   609/1000: dist 0.30 loss 6.24
step   610/1000: dist 0.30 loss 3.85
step   611/1000: dist 0.30 loss 4.49
step   612/1000: dist 0.30 loss 7.00
step   613/1000: dist 0.31 loss 8.26
```

```
step  614/1000: dist 0.30 loss 5.26
step  615/1000: dist 0.30 loss 1.53
step  616/1000: dist 0.30 loss 2.46
step  617/1000: dist 0.30 loss 5.71
step  618/1000: dist 0.30 loss 5.16
step  619/1000: dist 0.30 loss 1.92
step  620/1000: dist 0.30 loss 1.88
step  621/1000: dist 0.30 loss 4.64
step  622/1000: dist 0.30 loss 5.29
step  623/1000: dist 0.30 loss 4.01
step  624/1000: dist 0.30 loss 4.80
step  625/1000: dist 0.30 loss 7.59
step  626/1000: dist 0.30 loss 9.10
step  627/1000: dist 0.30 loss 8.84
step  628/1000: dist 0.30 loss 8.35
step  629/1000: dist 0.31 loss 7.26
step  630/1000: dist 0.30 loss 4.57
step  631/1000: dist 0.30 loss 1.69
step  632/1000: dist 0.30 loss 0.69
step  633/1000: dist 0.30 loss 1.75
step  634/1000: dist 0.30 loss 3.36
step  635/1000: dist 0.30 loss 4.01
step  636/1000: dist 0.30 loss 3.38
step  637/1000: dist 0.30 loss 2.57
step  638/1000: dist 0.30 loss 3.09
step  639/1000: dist 0.30 loss 5.89
step  640/1000: dist 0.30 loss 11.91
step  641/1000: dist 0.30 loss 22.09
step  642/1000: dist 0.30 loss 34.58
step  643/1000: dist 0.30 loss 37.51
step  644/1000: dist 0.30 loss 21.20
step  645/1000: dist 0.30 loss 2.17
step  646/1000: dist 0.30 loss 6.31
step  647/1000: dist 0.30 loss 19.65
step  648/1000: dist 0.30 loss 13.66
step  649/1000: dist 0.30 loss 1.24
step  650/1000: dist 0.30 loss 7.03
step  651/1000: dist 0.30 loss 13.04
step  652/1000: dist 0.30 loss 4.89
step  653/1000: dist 0.29 loss 4.49
step  654/1000: dist 0.30 loss 12.29
step  655/1000: dist 0.30 loss 9.99
step  656/1000: dist 0.30 loss 9.71
step  657/1000: dist 0.30 loss 17.31
step  658/1000: dist 0.30 loss 15.67
step  659/1000: dist 0.30 loss 9.88
step  660/1000: dist 0.30 loss 7.85
step  661/1000: dist 0.30 loss 2.58
```

```
step  662/1000: dist 0.30 loss 1.62
step  663/1000: dist 0.30 loss 7.38
step  664/1000: dist 0.30 loss 7.11
step  665/1000: dist 0.30 loss 3.95
step  666/1000: dist 0.30 loss 3.27
step  667/1000: dist 0.30 loss 1.98
step  668/1000: dist 0.30 loss 3.73
step  669/1000: dist 0.30 loss 6.29
step  670/1000: dist 0.30 loss 4.94
step  671/1000: dist 0.30 loss 5.91
step  672/1000: dist 0.30 loss 10.42
step  673/1000: dist 0.30 loss 16.02
step  674/1000: dist 0.29 loss 24.26
step  675/1000: dist 0.30 loss 31.65
step  676/1000: dist 0.29 loss 32.83
step  677/1000: dist 0.30 loss 25.51
step  678/1000: dist 0.30 loss 10.54
step  679/1000: dist 0.30 loss 1.28
step  680/1000: dist 0.30 loss 5.72
step  681/1000: dist 0.30 loss 13.81
step  682/1000: dist 0.30 loss 14.14
step  683/1000: dist 0.29 loss 6.32
step  684/1000: dist 0.30 loss 1.63
step  685/1000: dist 0.29 loss 7.07
step  686/1000: dist 0.30 loss 14.34
step  687/1000: dist 0.29 loss 17.52
step  688/1000: dist 0.29 loss 21.50
step  689/1000: dist 0.30 loss 23.34
step  690/1000: dist 0.30 loss 13.72
step  691/1000: dist 0.29 loss 4.13
step  692/1000: dist 0.30 loss 7.95
step  693/1000: dist 0.29 loss 13.76
step  694/1000: dist 0.29 loss 8.19
step  695/1000: dist 0.29 loss 2.99
step  696/1000: dist 0.29 loss 7.16
step  697/1000: dist 0.29 loss 7.80
step  698/1000: dist 0.29 loss 3.11
step  699/1000: dist 0.29 loss 4.45
step  700/1000: dist 0.29 loss 6.49
step  701/1000: dist 0.29 loss 3.36
step  702/1000: dist 0.29 loss 4.18
step  703/1000: dist 0.29 loss 8.17
step  704/1000: dist 0.29 loss 8.08
step  705/1000: dist 0.29 loss 10.52
step  706/1000: dist 0.29 loss 17.43
step  707/1000: dist 0.29 loss 18.52
step  708/1000: dist 0.29 loss 12.93
step  709/1000: dist 0.29 loss 7.10
```

```
step  710/1000: dist 0.29 loss 2.64
step  711/1000: dist 0.29 loss 2.74
step  712/1000: dist 0.29 loss 7.96
step  713/1000: dist 0.29 loss 9.53
step  714/1000: dist 0.29 loss 4.87
step  715/1000: dist 0.29 loss 2.97
step  716/1000: dist 0.29 loss 7.12
step  717/1000: dist 0.29 loss 12.72
step  718/1000: dist 0.29 loss 17.87
step  719/1000: dist 0.29 loss 22.91
step  720/1000: dist 0.29 loss 26.68
step  721/1000: dist 0.29 loss 23.46
step  722/1000: dist 0.29 loss 13.59
step  723/1000: dist 0.29 loss 9.42
step  724/1000: dist 0.29 loss 19.38
step  725/1000: dist 0.29 loss 30.52
step  726/1000: dist 0.29 loss 26.76
step  727/1000: dist 0.29 loss 13.86
step  728/1000: dist 0.29 loss 7.70
step  729/1000: dist 0.29 loss 8.01
step  730/1000: dist 0.29 loss 8.24
step  731/1000: dist 0.29 loss 9.47
step  732/1000: dist 0.29 loss 10.06
step  733/1000: dist 0.29 loss 5.50
step  734/1000: dist 0.29 loss 2.26
step  735/1000: dist 0.29 loss 6.17
step  736/1000: dist 0.29 loss 7.93
step  737/1000: dist 0.29 loss 2.99
step  738/1000: dist 0.29 loss 2.02
step  739/1000: dist 0.28 loss 6.60
step  740/1000: dist 0.29 loss 7.20
step  741/1000: dist 0.29 loss 6.12
step  742/1000: dist 0.29 loss 11.46
step  743/1000: dist 0.29 loss 19.38
step  744/1000: dist 0.29 loss 23.53
step  745/1000: dist 0.29 loss 22.60
step  746/1000: dist 0.29 loss 14.87
step  747/1000: dist 0.29 loss 4.25
step  748/1000: dist 0.29 loss 2.15
step  749/1000: dist 0.29 loss 8.85
step  750/1000: dist 0.29 loss 11.81
step  751/1000: dist 0.29 loss 5.97
step  752/1000: dist 0.29 loss 1.22
step  753/1000: dist 0.29 loss 4.28
step  754/1000: dist 0.28 loss 7.59
step  755/1000: dist 0.28 loss 4.51
step  756/1000: dist 0.28 loss 1.65
step  757/1000: dist 0.28 loss 4.99
```

```
step  758/1000: dist 0.28 loss 8.46
step  759/1000: dist 0.28 loss 8.44
step  760/1000: dist 0.28 loss 12.02
step  761/1000: dist 0.29 loss 20.58
step  762/1000: dist 0.28 loss 25.26
step  763/1000: dist 0.28 loss 21.08
step  764/1000: dist 0.28 loss 13.27
step  765/1000: dist 0.29 loss 8.67
step  766/1000: dist 0.29 loss 12.30
step  767/1000: dist 0.28 loss 21.45
step  768/1000: dist 0.28 loss 24.26
step  769/1000: dist 0.28 loss 15.15
step  770/1000: dist 0.28 loss 6.14
step  771/1000: dist 0.29 loss 6.03
step  772/1000: dist 0.29 loss 7.68
step  773/1000: dist 0.29 loss 6.63
step  774/1000: dist 0.28 loss 7.80
step  775/1000: dist 0.29 loss 8.91
step  776/1000: dist 0.28 loss 5.02
step  777/1000: dist 0.29 loss 2.89
step  778/1000: dist 0.28 loss 7.04
step  779/1000: dist 0.29 loss 8.93
step  780/1000: dist 0.29 loss 5.14
step  781/1000: dist 0.28 loss 3.72
step  782/1000: dist 0.28 loss 5.88
step  783/1000: dist 0.28 loss 5.14
step  784/1000: dist 0.28 loss 2.25
step  785/1000: dist 0.29 loss 1.55
step  786/1000: dist 0.28 loss 1.93
step  787/1000: dist 0.29 loss 1.91
step  788/1000: dist 0.29 loss 2.08
step  789/1000: dist 0.29 loss 1.93
step  790/1000: dist 0.29 loss 1.67
step  791/1000: dist 0.28 loss 1.87
step  792/1000: dist 0.29 loss 1.28
step  793/1000: dist 0.28 loss 0.43
step  794/1000: dist 0.29 loss 1.03
step  795/1000: dist 0.28 loss 1.52
step  796/1000: dist 0.29 loss 0.84
step  797/1000: dist 0.28 loss 0.70
step  798/1000: dist 0.29 loss 0.97
step  799/1000: dist 0.29 loss 0.59
step  800/1000: dist 0.28 loss 0.49
step  801/1000: dist 0.28 loss 0.82
step  802/1000: dist 0.28 loss 0.70
step  803/1000: dist 0.28 loss 0.46
step  804/1000: dist 0.28 loss 0.46
step  805/1000: dist 0.28 loss 0.51
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step  806/1000: dist 0.28 loss 0.55
step  807/1000: dist 0.28 loss 0.45
step  808/1000: dist 0.28 loss 0.39
step  809/1000: dist 0.28 loss 0.45
step  810/1000: dist 0.28 loss 0.38
step  811/1000: dist 0.28 loss 0.39
step  812/1000: dist 0.28 loss 0.44
step  813/1000: dist 0.28 loss 0.32
step  814/1000: dist 0.28 loss 0.33
step  815/1000: dist 0.28 loss 0.41
step  816/1000: dist 0.28 loss 0.32
step  817/1000: dist 0.28 loss 0.31
step  818/1000: dist 0.28 loss 0.35
step  819/1000: dist 0.28 loss 0.32
step  820/1000: dist 0.28 loss 0.32
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step  901/1000: dist 0.28 loss 0.28
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step  997/1000: dist 0.27 loss 0.27
```

```
step  998/1000: dist 0.27 loss 0.27
step  999/1000: dist 0.27 loss 0.27
step 1000/1000: dist 0.27 loss 0.27
Elapsed: 84.2 s
```

With the conversion complete, lets have a look at the two GANs.

```python
img_gan_source = cv2.imread('/content/out_source/proj.png')
img = cv2.cvtColor(img_gan_source, cv2.COLOR_BGR2RGB)
plt.imshow(img)
plt.title('source-gan')
plt.show()
```
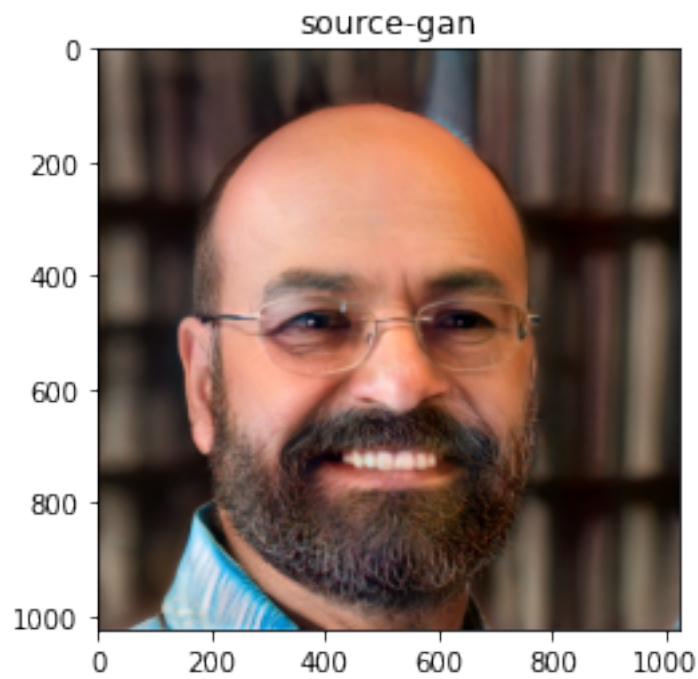


```python
img_gan_target = cv2.imread('/content/out_target/proj.png')
img = cv2.cvtColor(img_gan_target, cv2.COLOR_BGR2RGB)
plt.imshow(img)
plt.title('target-gan')
plt.show()
```

target-gan
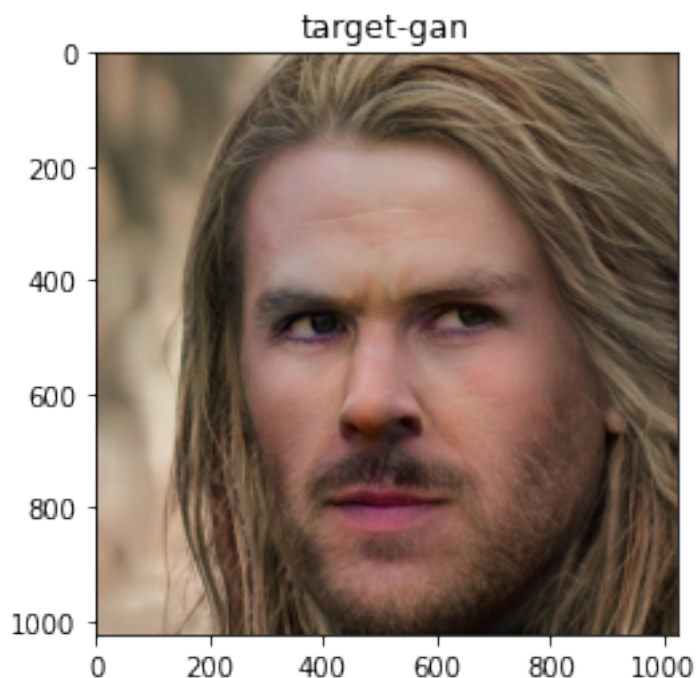
As you can see, the two GAN-generated images look similar to their real-world counterparts. However, they are by no means exact replicas.

4.7   Build the Video

The following code builds a transition video between the two latent vectors previously obtained.

```python
# HIDE OUTPUT
import torch
import dnnlib
import legacy
import PIL.Image
import numpy as np
import imageio
from tqdm.notebook import tqdm

lvec1 = np.load('/content/out_source/projected_w.npz')['w']
lvec2 = np.load('/content/out_target/projected_w.npz')['w']

network_pkl = "https://nvlabs-fi-cdn.nvidia.com/stylegan2"\
  "-ada-pytorch/pretrained/ffhq.pkl"
device = torch.device('cuda')
with dnnlib.util.open_url(network_pkl) as fp:
    G = legacy.load_network_pkl(fp)['G_ema']\
      .requires_grad_(False).to(device)
```

```
diff = lvec2 - lvec1
step = diff / STEPS
current = lvec1.copy()
target_uint8 = np.array([1024,1024,3], dtype=np.uint8)

video = imageio.get_writer('/content/movie.mp4', mode='I', fps=FPS,
                            codec='libx264', bitrate='16M')

for j in tqdm(range(STEPS)):
  z = torch.from_numpy(current).to(device)
  synth_image = G.synthesis(z, noise_mode='const')
  synth_image = (synth_image + 1) * (255/2)
  synth_image = synth_image.permute(0, 2, 3, 1).clamp(0, 255)\
    .to(torch.uint8)[0].cpu().numpy()

  repeat = FREEZE_STEPS if j==0 or j==(STEPS-1) else 1

  for i in range(repeat):
    video.append_data(synth_image)
  current = current + step


video.close()
```

  0%| | 0/150 [00:00<?, ?it/s]

Setting up PyTorch plugin "bias_act_plugin"… Done.
Setting up PyTorch plugin "upfirdn2d_plugin"… Done.

4.8 Download your Video

If you made it through all of these steps, you are now ready to download your video.

```
[ ]: # HIDE OUTPUT
     from google.colab import files
     files.download("movie.mp4")
```

<IPython.core.display.Javascript object>

<IPython.core.display.Javascript object>