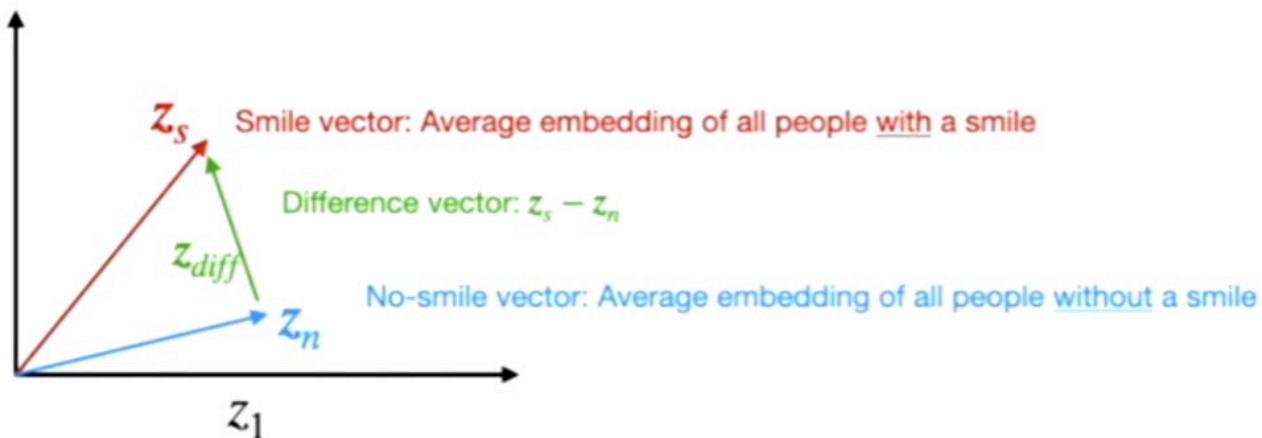


Latent Space Arithmetic



E.g., we can give a sad person a smile by

- $z_{new} = z_{orig} + \alpha \cdot z_{diff}$

Course website:

<http://pages.stat.wisc.edu/~sraschka/teaching/stat453-spring2021/>

GitHub repository:

<https://github.com/rasbt/stat453-deep-learning-spring2021>

Convolutional Variational Autoencoder for CelebA Face Images

In [1]:

```
%load_ext watermark  
%watermark -a 'Sebastian Raschka' -v -p
```

Author: Sebastian Raschka

Python implementation: CPython

Python version : 3.8.8

IPython version : 7.21.0

torch: 1.8.1

Imports

In [2]:

```
import torch  
import torchvision  
import torch.nn as nn  
import matplotlib.pyplot as plt
```

Import utility functions

In [3]:

```
from helper_data import get_dataloaders_
from helper_data import UnNormalize
from helper_train import train_vae_v1
from helper_utils import set_deterministic
from helper_plotting import plot_accuracy
from helper_plotting import plot_generated
from helper_plotting import plot_latent_
from helper_plotting import plot_images_:
```

In [4]:

```
#####
### SETTINGS
#####

# Device
CUDA_DEVICE_NUM = 1
DEVICE = torch.device(f'cuda:{CUDA_DEVICE_NUM}')
print('Device:', DEVICE)

# Hyperparameters
RANDOM_SEED = 123
LEARNING_RATE = 0.0005
BATCH_SIZE = 256
NUM_EPOCHS = 50
```

Device: cuda:1

In [5]:

```
set_deterministic
set_all_seeds(RANDOM_SEED)
```

Dataset

In [6]:

```
#####
### Dataset
#####

custom_transforms = torchvision.transforms.Compose([
    torchvision.transforms.CenterCrop((128, 128)),
    torchvision.transforms.ToTensor(),
    #torchvision.transforms.Normalize((0.485, 0.485, 0.485), (0.229, 0.229, 0.229))
])

train_loader, valid_loader, test_loader = torch.utils.data.DataLoader(
    dataset,
    batch_size=BATCH_SIZE,
    train_transforms=custom_transforms,
    test_transforms=custom_transforms,
    num_workers=2)
```

Files already downloaded and verified

In [7]:

```
# Checking the dataset
print('Training Set:\n')
for images, labels in train_loader:
    print('Image batch dimensions:', images.shape)
    print('Image label dimensions:', labels.shape)
    #print(labels[:10])
    break

# Checking the dataset
print('\nValidation Set:')
for images, labels in valid_loader:
    print('Image batch dimensions:', images.shape)
    print('Image label dimensions:', labels.shape)
    #print(labels[:10])
    break

# Checking the dataset
print('\nTesting Set:')
for images, labels in test_loader:
    print('Image batch dimensions:', images.shape)
    print('Image label dimensions:', labels.shape)
    #print(labels[:10])
    break
```

```
"""Targets are 40-dim vectors representing faces.
00 - 5_o_Clock_Shadow
01 - Arched_Eyebrows
02 - Attractive
03 - Bags_Under_Eyes
04 - Bald
05 - Bangs
06 - Big_Lips
07 - Big_Nose
08 - Black_Hair
09 - Blond_Hair
10 - Blurry
11 - Brown_Hair
12 - Bushy_Eyebrows
13 - Chubby
14 - Double_Chin
15 - Eyeglasses
16 - Goatee
17 - Gray_Hair
18 - Heavy_Makeup
19 - High_Cheekbones
20 - Male
21 - Mouth_Slightly_Open
22 - Mustache
23 - Narrow_Eyes
24 - No_Beard
25 - Oval_Face
26 - Pale_Skin
27 - Pointy_Nose
28 - Receding_Hairline
29 - Rosy_Cheeks
30 - Sideburns
31 - Smiling
32 - Straight_Hair
33 - Wavy_Hair
34 - Wearing_Earrings
35 - Wearing_Hat
36 - Wearing_Lipstick
37 - Wearing_Necklace
38 - Wearing_Necktie
39 - Young
"""
```

Training Set:

Image batch dimensions: torch.Size([256, 3, 128, 128])
Image label dimensions: torch.Size([256, 40])

Validation Set:

Image batch dimensions: torch.Size([256, 3, 128, 128])
Image label dimensions: torch.Size([256, 40])

Testing Set:

Image batch dimensions: torch.Size([256, 3, 128, 128])
Image label dimensions: torch.Size([256, 40])

Out[7]:

'Targets are 40-dim vectors representing
\n00 - 5_o_Clock_Shadow\n01 - Arched_Eyebrows\n02 - Attractive \n03 - Bags_Under_Eyes\n04 - Bald\n05 - Bangs\n06 - Big_Lips\n07 - Big_Nose\n08 - Black_Hair\n09 - Blond_Hair\n10 - Blurry \n11 - Brown_Hair\n12 - Bushy_Eyebrows \n13 - Chubby \n14 - Double_Chin \n15 - Eyeglasses \n16 - Goatee \n17 - Gray_Hair \n18 - Heavy_Makeup\n19 - High_Cheekbones \n20 - Male \n21 - Mouth_Slightly_Open \n22 - Mustache \n23 - Narrow_Eyes \n24 - No_Beard \n25 - Oval_Face \n26 - Pale_Skin \n27 - Pointy_Nose\n28 - Receding_Hairline \n29 - Rosy_Cheeks \n30 - Sideburns \n31 - Smiling \n32 - Straight_Hair \n33 - Wavy_Hair \n34 - Wearing_Earrings \n35 - Wearing_Hat \n36 - Wearing_Lipstick \n37 - Wearing_Necklace\n38 - Wearing_Necktie \n39 - Young\n\\n'

Model

In [8]:

```
#  
    nn.Conv2d(64, 64, stride:  
    nn.BatchNorm2d(64),  
    nn.LeakyReLU(0.1, inplace:  
    nn.Dropout2d(0.25),  
    #  
    nn.Flatten(),  
)  
  
self.z_mean = torch.nn.Linear(4096, 200)  
self.z_log_var = torch.nn.Linear(4096, 200)  
  
self.decoder = nn.Sequential(  
    torch.nn.Linear(200, 4096),  
    Reshape(-1, 64, 8, 8),  
    #  
    nn.ConvTranspose2d(64, 64, 4, 2),  
    nn.BatchNorm2d(64),  
    nn.LeakyReLU(0.1, inplace:  
    nn.Dropout2d(0.25),  
    #  
    nn.ConvTranspose2d(64, 64, 4, 2),  
    nn.BatchNorm2d(64),  
    nn.LeakyReLU(0.1, inplace:  
    nn.Dropout2d(0.25),  
    #  
    nn.ConvTranspose2d(64, 32, 4, 2),  
    nn.BatchNorm2d(32),  
    nn.LeakyReLU(0.1, inplace:  
    nn.Dropout2d(0.25),  
    #  
    nn.ConvTranspose2d(32, 32, 4, 2),  
    #  
    Trim(), # 3x129x129 -> 3x128x128  
    nn.Sigmoid()  
)
```

```
def encoding_fn(self, x):
    x = self.encoder(x)
    z_mean, z_log_var = self.z_mean()
    encoded = self.reparameterize(z_mean, z_log_var)
    return encoded

def reparameterize(self, z_mu, z_log_var):
    eps = torch.randn(z_mu.size(0), device=z_mu.device)
    z = z_mu + eps * torch.exp(z_log_var)
    return z

def forward(self, x):
    x = self.encoder(x)
    z_mean, z_log_var = self.z_mean()
    encoded = self.reparameterize(z_mean, z_log_var)
    decoded = self.decoder(encoded)
    return encoded, z_mean, z_log_var
```

In [9]:

```
set_all_seeds(RANDOM_SEED)

model = VAE()
model.to(DEVICE)

optimizer = torch.optim.Adam(model.parameters(), lr=LEARNING_RATE)
```

Training

In [10]:

```
log_dict = train_vae_v1(num_epochs=NUM_EI  
                        optimizer=optimi:  
                        train_loader=tra:  
                        skip_epoch_stats:  
                        logging_interval:  
                        save_model='vae_'
```

```
Epoch: 001/050 | Batch 0000/0636 | Loss:  
5556.6865  
Epoch: 001/050 | Batch 0050/0636 | Loss:  
2205.2812  
Epoch: 001/050 | Batch 0100/0636 | Loss:  
1487.1965  
Epoch: 001/050 | Batch 0150/0636 | Loss:  
1288.5625  
Epoch: 001/050 | Batch 0200/0636 | Loss:  
1131.7750  
Epoch: 001/050 | Batch 0250/0636 | Loss:  
1029.1233  
Epoch: 001/050 | Batch 0300/0636 | Loss:  
1010.5161  
Epoch: 001/050 | Batch 0350/0636 | Loss:  
968.1432  
Epoch: 001/050 | Batch 0400/0636 | Loss:  
936.7646  
Epoch: 001/050 | Batch 0450/0636 | Loss:  
946.5043  
Epoch: 001/050 | Batch 0500/0636 | Loss:  
860.4714  
Epoch: 001/050 | Batch 0550/0636 | Loss:  
853.9331  
Epoch: 001/050 | Batch 0600/0636 | Loss:  
845.3600  
Time elapsed: 1.60 min  
Epoch: 002/050 | Batch 0000/0636 | Loss:  
848.1174  
Epoch: 002/050 | Batch 0050/0636 | Loss:  
795.7545  
Epoch: 002/050 | Batch 0100/0636 | Loss:  
794.8246  
Epoch: 002/050 | Batch 0150/0636 | Loss:  
798.5274  
Epoch: 002/050 | Batch 0200/0636 | Loss:  
793.1392  
Epoch: 002/050 | Batch 0250/0636 | Loss:  
775.0523  
Epoch: 002/050 | Batch 0300/0636 | Loss:
```

Epoch: 002/050 | Batch 0250/0636 | Loss: 775.0523
Epoch: 002/050 | Batch 0300/0636 | Loss: 727.1198
Epoch: 002/050 | Batch 0350/0636 | Loss: 795.2505
Epoch: 002/050 | Batch 0400/0636 | Loss: 765.5392
Epoch: 002/050 | Batch 0450/0636 | Loss: 754.1130
Epoch: 002/050 | Batch 0500/0636 | Loss: 741.0908
Epoch: 002/050 | Batch 0550/0636 | Loss: 740.9390
Epoch: 002/050 | Batch 0600/0636 | Loss: 738.5259
Time elapsed: 3.23 min
Epoch: 003/050 | Batch 0000/0636 | Loss: 718.9746
Epoch: 003/050 | Batch 0050/0636 | Loss: 725.7620
Epoch: 003/050 | Batch 0100/0636 | Loss: 708.1959
Epoch: 003/050 | Batch 0150/0636 | Loss: 721.1913
Epoch: 003/050 | Batch 0200/0636 | Loss: 741.0513
Epoch: 003/050 | Batch 0250/0636 | Loss: 727.3040
Epoch: 003/050 | Batch 0300/0636 | Loss: 722.3228
Epoch: 003/050 | Batch 0350/0636 | Loss: 686.6407
Epoch: 003/050 | Batch 0400/0636 | Loss: 704.4551
Epoch: 003/050 | Batch 0450/0636 | Loss: 691.1871
Epoch: 003/050 | Batch 0500/0636 | Loss: 701.8396
Epoch: 003/050 | Batch 0550/0636 | Loss: 683.9158
Epoch: 003/050 | Batch 0600/0636 | Loss: 697.0040
Time elapsed: 4.99 min
Epoch: 004/050 | Batch 0000/0636 | Loss: 696.3093
Epoch: 004/050 | Batch 0050/0636 | Loss: 687.8564
Epoch: 004/050 | Batch 0100/0636 | Loss: 678.2861
Epoch: 004/050 | Batch 0150/0636 | Loss: 703.4927

Epoch: 004/050 | Batch 0050/0636 | Loss: 687.8564
Epoch: 004/050 | Batch 0100/0636 | Loss: 678.2861
Epoch: 004/050 | Batch 0150/0636 | Loss: 703.4927
Epoch: 004/050 | Batch 0200/0636 | Loss: 702.5364
Epoch: 004/050 | Batch 0250/0636 | Loss: 680.6151
Epoch: 004/050 | Batch 0300/0636 | Loss: 662.0529
Epoch: 004/050 | Batch 0350/0636 | Loss: 688.2006
Epoch: 004/050 | Batch 0400/0636 | Loss: 702.1727
Epoch: 004/050 | Batch 0450/0636 | Loss: 679.2972
Epoch: 004/050 | Batch 0500/0636 | Loss: 688.8722
Epoch: 004/050 | Batch 0550/0636 | Loss: 644.1266
Epoch: 004/050 | Batch 0600/0636 | Loss: 673.9162
Time elapsed: 6.64 min
Epoch: 005/050 | Batch 0000/0636 | Loss: 665.7782
Epoch: 005/050 | Batch 0050/0636 | Loss: 676.7981
Epoch: 005/050 | Batch 0100/0636 | Loss: 669.0072
Epoch: 005/050 | Batch 0150/0636 | Loss: 669.5605
Epoch: 005/050 | Batch 0200/0636 | Loss: 677.4598
Epoch: 005/050 | Batch 0250/0636 | Loss: 653.0551
Epoch: 005/050 | Batch 0300/0636 | Loss: 662.9146
Epoch: 005/050 | Batch 0350/0636 | Loss: 667.8948
Epoch: 005/050 | Batch 0400/0636 | Loss: 665.3439
Epoch: 005/050 | Batch 0450/0636 | Loss: 642.1831
Epoch: 005/050 | Batch 0500/0636 | Loss: 645.6768
Epoch: 005/050 | Batch 0550/0636 | Loss: 643.9138
Epoch: 005/050 | Batch 0600/0636 | Loss: 654.4271
Time elapsed: 8.34 min

Time elapsed: 8.34 min
Epoch: 006/050 | Batch 0000/0636 | Loss: 670.0407
Epoch: 006/050 | Batch 0050/0636 | Loss: 654.4934
Epoch: 006/050 | Batch 0100/0636 | Loss: 649.9948
Epoch: 006/050 | Batch 0150/0636 | Loss: 644.7177
Epoch: 006/050 | Batch 0200/0636 | Loss: 645.7147
Epoch: 006/050 | Batch 0250/0636 | Loss: 643.1758
Epoch: 006/050 | Batch 0300/0636 | Loss: 640.3911
Epoch: 006/050 | Batch 0350/0636 | Loss: 635.0331
Epoch: 006/050 | Batch 0400/0636 | Loss: 661.2003
Epoch: 006/050 | Batch 0450/0636 | Loss: 653.5791
Epoch: 006/050 | Batch 0500/0636 | Loss: 648.4429
Epoch: 006/050 | Batch 0550/0636 | Loss: 654.2988
Epoch: 006/050 | Batch 0600/0636 | Loss: 624.6424
Time elapsed: 10.08 min
Epoch: 007/050 | Batch 0000/0636 | Loss: 645.3398
Epoch: 007/050 | Batch 0050/0636 | Loss: 639.3365
Epoch: 007/050 | Batch 0100/0636 | Loss: 678.5773
Epoch: 007/050 | Batch 0150/0636 | Loss: 630.6527
Epoch: 007/050 | Batch 0200/0636 | Loss: 635.6730
Epoch: 007/050 | Batch 0250/0636 | Loss: 608.2228
Epoch: 007/050 | Batch 0300/0636 | Loss: 639.4207
Epoch: 007/050 | Batch 0350/0636 | Loss: 624.6892
Epoch: 007/050 | Batch 0400/0636 | Loss: 655.8571
Epoch: 007/050 | Batch 0450/0636 | Loss: 638.0177
Epoch: 007/050 | Batch 0500/0636 | Loss: 644.5380
Epoch: 007/050 | Batch 0550/0636 | Loss: 641.6013

Epoch: 007/050 | Batch 0550/0636 | Loss: 644.5580
Epoch: 007/050 | Batch 0600/0636 | Loss: 641.6013
Epoch: 007/050 | Batch 0650/0636 | Loss: 614.6763
Time elapsed: 11.71 min
Epoch: 008/050 | Batch 0000/0636 | Loss: 645.7891
Epoch: 008/050 | Batch 0050/0636 | Loss: 625.9609
Epoch: 008/050 | Batch 0100/0636 | Loss: 642.8795
Epoch: 008/050 | Batch 0150/0636 | Loss: 624.8649
Epoch: 008/050 | Batch 0200/0636 | Loss: 617.1541
Epoch: 008/050 | Batch 0250/0636 | Loss: 618.3403
Epoch: 008/050 | Batch 0300/0636 | Loss: 645.0806
Epoch: 008/050 | Batch 0350/0636 | Loss: 633.3391
Epoch: 008/050 | Batch 0400/0636 | Loss: 617.1105
Epoch: 008/050 | Batch 0450/0636 | Loss: 613.9218
Epoch: 008/050 | Batch 0500/0636 | Loss: 646.6736
Epoch: 008/050 | Batch 0550/0636 | Loss: 601.8243
Epoch: 008/050 | Batch 0600/0636 | Loss: 618.8941
Time elapsed: 13.31 min
Epoch: 009/050 | Batch 0000/0636 | Loss: 630.2963
Epoch: 009/050 | Batch 0050/0636 | Loss: 648.0725
Epoch: 009/050 | Batch 0100/0636 | Loss: 592.2516
Epoch: 009/050 | Batch 0150/0636 | Loss: 621.5770
Epoch: 009/050 | Batch 0200/0636 | Loss: 617.2924
Epoch: 009/050 | Batch 0250/0636 | Loss: 620.3580
Epoch: 009/050 | Batch 0300/0636 | Loss: 622.0060

```
Epoch: 009/050 | Batch 0350/0636 | Loss:  
611.2636  
Epoch: 009/050 | Batch 0400/0636 | Loss:  
632.3724  
Epoch: 009/050 | Batch 0450/0636 | Loss:  
646.2676  
Epoch: 009/050 | Batch 0500/0636 | Loss:  
604.1435  
Epoch: 009/050 | Batch 0550/0636 | Loss:  
614.9801  
Epoch: 009/050 | Batch 0600/0636 | Loss:  
617.8130  
Time elapsed: 14.91 min  
Epoch: 010/050 | Batch 0000/0636 | Loss:  
605.4973  
Epoch: 010/050 | Batch 0050/0636 | Loss:  
599.3066  
Epoch: 010/050 | Batch 0100/0636 | Loss:  
636.4790  
Epoch: 010/050 | Batch 0150/0636 | Loss:  
604.9612  
Epoch: 010/050 | Batch 0200/0636 | Loss:  
598.5984  
Epoch: 010/050 | Batch 0250/0636 | Loss:  
625.6672  
Epoch: 010/050 | Batch 0300/0636 | Loss:  
619.7579  
Epoch: 010/050 | Batch 0350/0636 | Loss:  
609.1120  
Epoch: 010/050 | Batch 0400/0636 | Loss:  
623.0068  
Epoch: 010/050 | Batch 0450/0636 | Loss:  
618.6660  
Epoch: 010/050 | Batch 0500/0636 | Loss:  
593.2754  
Epoch: 010/050 | Batch 0550/0636 | Loss:  
598.0289  
Epoch: 010/050 | Batch 0600/0636 | Loss:  
622.3903  
Time elapsed: 16.52 min  
Epoch: 011/050 | Batch 0000/0636 | Loss:  
634.2999  
Epoch: 011/050 | Batch 0050/0636 | Loss:  
609.0602  
Epoch: 011/050 | Batch 0100/0636 | Loss:  
602.3773
```

Epoch: 011/050 | Batch 0150/0636 | Loss: 634.2097
Epoch: 011/050 | Batch 0200/0636 | Loss: 602.5477
Epoch: 011/050 | Batch 0250/0636 | Loss: 593.3793
Epoch: 011/050 | Batch 0300/0636 | Loss: 611.8711
Epoch: 011/050 | Batch 0350/0636 | Loss: 605.4591
Epoch: 011/050 | Batch 0400/0636 | Loss: 633.7789
Epoch: 011/050 | Batch 0450/0636 | Loss: 603.0186
Epoch: 011/050 | Batch 0500/0636 | Loss: 603.8940
Epoch: 011/050 | Batch 0550/0636 | Loss: 606.7372
Epoch: 011/050 | Batch 0600/0636 | Loss: 612.7875
Time elapsed: 18.16 min
Epoch: 012/050 | Batch 0000/0636 | Loss: 600.5385
Epoch: 012/050 | Batch 0050/0636 | Loss: 602.9553
Epoch: 012/050 | Batch 0100/0636 | Loss: 639.3524
Epoch: 012/050 | Batch 0150/0636 | Loss: 588.7831
Epoch: 012/050 | Batch 0200/0636 | Loss: 612.3264
Epoch: 012/050 | Batch 0250/0636 | Loss: 616.6312
Epoch: 012/050 | Batch 0300/0636 | Loss: 594.2166
Epoch: 012/050 | Batch 0350/0636 | Loss: 595.8284
Epoch: 012/050 | Batch 0400/0636 | Loss: 595.8541
Epoch: 012/050 | Batch 0450/0636 | Loss: 597.6486
Epoch: 012/050 | Batch 0500/0636 | Loss: 597.1218
Epoch: 012/050 | Batch 0550/0636 | Loss: 622.0735
Epoch: 012/050 | Batch 0600/0636 | Loss: 611.0302
Time elapsed: 19.78 min
Epoch: 013/050 | Batch 0000/0636 | Loss: 617.1995
Epoch: 013/050 | Batch 0050/0636 | Loss: 591.3622

Epoch: 013/050 | Batch 0050/0636 | Loss: 591.3622
Epoch: 013/050 | Batch 0100/0636 | Loss: 598.8687
Epoch: 013/050 | Batch 0150/0636 | Loss: 613.9990
Epoch: 013/050 | Batch 0200/0636 | Loss: 604.3148
Epoch: 013/050 | Batch 0250/0636 | Loss: 604.3667
Epoch: 013/050 | Batch 0300/0636 | Loss: 617.6729
Epoch: 013/050 | Batch 0350/0636 | Loss: 594.7616
Epoch: 013/050 | Batch 0400/0636 | Loss: 603.5470
Epoch: 013/050 | Batch 0450/0636 | Loss: 600.2432
Epoch: 013/050 | Batch 0500/0636 | Loss: 580.9159
Epoch: 013/050 | Batch 0550/0636 | Loss: 615.0181
Epoch: 013/050 | Batch 0600/0636 | Loss: 595.0588
Time elapsed: 21.38 min
Epoch: 014/050 | Batch 0000/0636 | Loss: 636.7670
Epoch: 014/050 | Batch 0050/0636 | Loss: 612.6865
Epoch: 014/050 | Batch 0100/0636 | Loss: 586.1139
Epoch: 014/050 | Batch 0150/0636 | Loss: 599.9659
Epoch: 014/050 | Batch 0200/0636 | Loss: 614.9221
Epoch: 014/050 | Batch 0250/0636 | Loss: 599.2103
Epoch: 014/050 | Batch 0300/0636 | Loss: 568.0521
Epoch: 014/050 | Batch 0350/0636 | Loss: 619.2092
Epoch: 014/050 | Batch 0400/0636 | Loss: 601.3911
Epoch: 014/050 | Batch 0450/0636 | Loss: 606.6124
Epoch: 014/050 | Batch 0500/0636 | Loss: 590.8621
Epoch: 014/050 | Batch 0550/0636 | Loss: 609.3073
Epoch: 014/050 | Batch 0600/0636 | Loss: 598.2911
Time elapsed: 23.05 min

598.2911
Time elapsed: 23.05 min
Epoch: 015/050 | Batch 0000/0636 | Loss:
588.8418
Epoch: 015/050 | Batch 0050/0636 | Loss:
593.4137
Epoch: 015/050 | Batch 0100/0636 | Loss:
570.8494
Epoch: 015/050 | Batch 0150/0636 | Loss:
573.6625
Epoch: 015/050 | Batch 0200/0636 | Loss:
620.1381
Epoch: 015/050 | Batch 0250/0636 | Loss:
603.4213
Epoch: 015/050 | Batch 0300/0636 | Loss:
584.8630
Epoch: 015/050 | Batch 0350/0636 | Loss:
586.5802
Epoch: 015/050 | Batch 0400/0636 | Loss:
598.8683
Epoch: 015/050 | Batch 0450/0636 | Loss:
575.8959
Epoch: 015/050 | Batch 0500/0636 | Loss:
590.7325
Epoch: 015/050 | Batch 0550/0636 | Loss:
598.0607
Epoch: 015/050 | Batch 0600/0636 | Loss:
627.9670
Time elapsed: 24.68 min
Epoch: 016/050 | Batch 0000/0636 | Loss:
620.2567
Epoch: 016/050 | Batch 0050/0636 | Loss:
578.7848
Epoch: 016/050 | Batch 0100/0636 | Loss:
590.6666
Epoch: 016/050 | Batch 0150/0636 | Loss:
586.5486
Epoch: 016/050 | Batch 0200/0636 | Loss:
581.2667
Epoch: 016/050 | Batch 0250/0636 | Loss:
587.4363
Epoch: 016/050 | Batch 0300/0636 | Loss:
600.3987
Epoch: 016/050 | Batch 0350/0636 | Loss:
595.6329
Epoch: 016/050 | Batch 0400/0636 | Loss:
600.3650
Epoch: 016/050 | Batch 0450/0636 | Loss:
595.4367
Epoch: 016/050 | Batch 0500/0636 | Loss:
607.1689
Epoch: 016/050 | Batch 0550/0636 | Loss:

Epoch: 016/050 | Batch 0500/0636 | Loss: 607.1689
Epoch: 016/050 | Batch 0550/0636 | Loss: 585.5055
Epoch: 016/050 | Batch 0600/0636 | Loss: 577.1095
Time elapsed: 26.30 min
Epoch: 017/050 | Batch 0000/0636 | Loss: 610.5564
Epoch: 017/050 | Batch 0050/0636 | Loss: 584.6497
Epoch: 017/050 | Batch 0100/0636 | Loss: 577.5483
Epoch: 017/050 | Batch 0150/0636 | Loss: 564.8790
Epoch: 017/050 | Batch 0200/0636 | Loss: 584.8928
Epoch: 017/050 | Batch 0250/0636 | Loss: 602.2416
Epoch: 017/050 | Batch 0300/0636 | Loss: 611.3719
Epoch: 017/050 | Batch 0350/0636 | Loss: 620.3971
Epoch: 017/050 | Batch 0400/0636 | Loss: 583.0554
Epoch: 017/050 | Batch 0450/0636 | Loss: 602.6344
Epoch: 017/050 | Batch 0500/0636 | Loss: 590.1962
Epoch: 017/050 | Batch 0550/0636 | Loss: 564.1794
Epoch: 017/050 | Batch 0600/0636 | Loss: 612.1229
Time elapsed: 27.92 min
Epoch: 018/050 | Batch 0000/0636 | Loss: 589.3411
Epoch: 018/050 | Batch 0050/0636 | Loss: 579.8397
Epoch: 018/050 | Batch 0100/0636 | Loss: 578.7898
Epoch: 018/050 | Batch 0150/0636 | Loss: 605.3534
Epoch: 018/050 | Batch 0200/0636 | Loss: 571.9902
Epoch: 018/050 | Batch 0250/0636 | Loss: 567.1129
Epoch: 018/050 | Batch 0300/0636 | Loss: 599.8524
Epoch: 018/050 | Batch 0350/0636 | Loss: 599.0140
Epoch: 018/050 | Batch 0400/0636 | Loss: 567.8417

Epoch: 018/050 | Batch 0400/0636 | Loss: 567.8417
Epoch: 018/050 | Batch 0450/0636 | Loss: 586.3140
Epoch: 018/050 | Batch 0500/0636 | Loss: 581.8481
Epoch: 018/050 | Batch 0550/0636 | Loss: 608.6926
Epoch: 018/050 | Batch 0600/0636 | Loss: 570.6066
Time elapsed: 29.62 min
Epoch: 019/050 | Batch 0000/0636 | Loss: 588.7641
Epoch: 019/050 | Batch 0050/0636 | Loss: 580.4756
Epoch: 019/050 | Batch 0100/0636 | Loss: 610.6464
Epoch: 019/050 | Batch 0150/0636 | Loss: 606.5475
Epoch: 019/050 | Batch 0200/0636 | Loss: 587.3675
Epoch: 019/050 | Batch 0250/0636 | Loss: 593.5841
Epoch: 019/050 | Batch 0300/0636 | Loss: 577.2062
Epoch: 019/050 | Batch 0350/0636 | Loss: 599.0832
Epoch: 019/050 | Batch 0400/0636 | Loss: 588.5621
Epoch: 019/050 | Batch 0450/0636 | Loss: 599.5743
Epoch: 019/050 | Batch 0500/0636 | Loss: 581.8420
Epoch: 019/050 | Batch 0550/0636 | Loss: 576.1855
Epoch: 019/050 | Batch 0600/0636 | Loss: 587.0692
Time elapsed: 31.22 min
Epoch: 020/050 | Batch 0000/0636 | Loss: 568.4170
Epoch: 020/050 | Batch 0050/0636 | Loss: 570.8328
Epoch: 020/050 | Batch 0100/0636 | Loss: 585.1000
Epoch: 020/050 | Batch 0150/0636 | Loss: 587.0583
Epoch: 020/050 | Batch 0200/0636 | Loss: 600.9928
Epoch: 020/050 | Batch 0250/0636 | Loss: 598.5024

Epoch: 020/050 | Batch 0300/0636 | Loss: 590.3024
Epoch: 020/050 | Batch 0350/0636 | Loss: 594.8728
Epoch: 020/050 | Batch 0400/0636 | Loss: 575.4216
Epoch: 020/050 | Batch 0450/0636 | Loss: 585.7893
Epoch: 020/050 | Batch 0500/0636 | Loss: 594.2159
Epoch: 020/050 | Batch 0550/0636 | Loss: 595.1122
Epoch: 020/050 | Batch 0600/0636 | Loss: 611.3309
Time elapsed: 32.84 min
Epoch: 021/050 | Batch 0000/0636 | Loss: 583.1333
Epoch: 021/050 | Batch 0050/0636 | Loss: 602.4030
Epoch: 021/050 | Batch 0100/0636 | Loss: 597.1732
Epoch: 021/050 | Batch 0150/0636 | Loss: 580.2554
Epoch: 021/050 | Batch 0200/0636 | Loss: 589.3398
Epoch: 021/050 | Batch 0250/0636 | Loss: 585.8528
Epoch: 021/050 | Batch 0300/0636 | Loss: 587.2554
Epoch: 021/050 | Batch 0350/0636 | Loss: 584.8591
Epoch: 021/050 | Batch 0400/0636 | Loss: 585.9128
Epoch: 021/050 | Batch 0450/0636 | Loss: 576.4485
Epoch: 021/050 | Batch 0500/0636 | Loss: 579.2234
Epoch: 021/050 | Batch 0550/0636 | Loss: 570.0542
Epoch: 021/050 | Batch 0600/0636 | Loss: 589.7507
Time elapsed: 34.44 min
Epoch: 022/050 | Batch 0000/0636 | Loss: 586.7245
Epoch: 022/050 | Batch 0050/0636 | Loss: 609.1318
Epoch: 022/050 | Batch 0100/0636 | Loss: 577.0483
Epoch: 022/050 | Batch 0150/0636 | Loss: 582.0347
Epoch: 022/050 | Batch 0200/0636 | Loss: 585.2455
Epoch: 022/050 | Batch 0250/0636 | Loss:

Epoch: 022/050 | Batch 0200/0636 | Loss: 585.2455
Epoch: 022/050 | Batch 0250/0636 | Loss: 587.6262
Epoch: 022/050 | Batch 0300/0636 | Loss: 585.0142
Epoch: 022/050 | Batch 0350/0636 | Loss: 576.8198
Epoch: 022/050 | Batch 0400/0636 | Loss: 578.8835
Epoch: 022/050 | Batch 0450/0636 | Loss: 568.4438
Epoch: 022/050 | Batch 0500/0636 | Loss: 584.5043
Epoch: 022/050 | Batch 0550/0636 | Loss: 589.5255
Epoch: 022/050 | Batch 0600/0636 | Loss: 570.7998
Time elapsed: 36.07 min
Epoch: 023/050 | Batch 0000/0636 | Loss: 587.1451
Epoch: 023/050 | Batch 0050/0636 | Loss: 594.3780
Epoch: 023/050 | Batch 0100/0636 | Loss: 585.9813
Epoch: 023/050 | Batch 0150/0636 | Loss: 570.5031
Epoch: 023/050 | Batch 0200/0636 | Loss: 572.6146
Epoch: 023/050 | Batch 0250/0636 | Loss: 617.7686
Epoch: 023/050 | Batch 0300/0636 | Loss: 580.6904
Epoch: 023/050 | Batch 0350/0636 | Loss: 557.6614
Epoch: 023/050 | Batch 0400/0636 | Loss: 577.1584
Epoch: 023/050 | Batch 0450/0636 | Loss: 569.5354
Epoch: 023/050 | Batch 0500/0636 | Loss: 575.0637
Epoch: 023/050 | Batch 0550/0636 | Loss: 578.2274
Epoch: 023/050 | Batch 0600/0636 | Loss: 582.4646
Time elapsed: 37.69 min
Epoch: 024/050 | Batch 0000/0636 | Loss: 572.1554
Epoch: 024/050 | Batch 0050/0636 | Loss: 578.9758
Epoch: 024/050 | Batch 0100/0636 | Loss:

Epoch: 024/050 | Batch 0100/0636 | Loss: 580.3715
Epoch: 024/050 | Batch 0150/0636 | Loss: 568.5997
Epoch: 024/050 | Batch 0200/0636 | Loss: 571.4485
Epoch: 024/050 | Batch 0250/0636 | Loss: 559.8994
Epoch: 024/050 | Batch 0300/0636 | Loss: 595.0832
Epoch: 024/050 | Batch 0350/0636 | Loss: 579.8757
Epoch: 024/050 | Batch 0400/0636 | Loss: 588.9042
Epoch: 024/050 | Batch 0450/0636 | Loss: 572.2966
Epoch: 024/050 | Batch 0500/0636 | Loss: 573.7598
Epoch: 024/050 | Batch 0550/0636 | Loss: 574.4077
Epoch: 024/050 | Batch 0600/0636 | Loss: 571.7828
Time elapsed: 39.31 min
Epoch: 025/050 | Batch 0000/0636 | Loss: 594.5736
Epoch: 025/050 | Batch 0050/0636 | Loss: 570.0574
Epoch: 025/050 | Batch 0100/0636 | Loss: 581.5618
Epoch: 025/050 | Batch 0150/0636 | Loss: 565.9681
Epoch: 025/050 | Batch 0200/0636 | Loss: 583.3434
Epoch: 025/050 | Batch 0250/0636 | Loss: 582.7817
Epoch: 025/050 | Batch 0300/0636 | Loss: 581.6898
Epoch: 025/050 | Batch 0350/0636 | Loss: 592.5389
Epoch: 025/050 | Batch 0400/0636 | Loss: 567.4542
Epoch: 025/050 | Batch 0450/0636 | Loss: 603.3939
Epoch: 025/050 | Batch 0500/0636 | Loss: 592.4799
Epoch: 025/050 | Batch 0550/0636 | Loss: 573.1910
Epoch: 025/050 | Batch 0600/0636 | Loss: 587.7805
Time elapsed: 40.92 min

Time elapsed: 40.92 min
Epoch: 026/050 | Batch 0000/0636 | Loss:
588.1301
Epoch: 026/050 | Batch 0050/0636 | Loss:
585.7178
Epoch: 026/050 | Batch 0100/0636 | Loss:
589.4291
Epoch: 026/050 | Batch 0150/0636 | Loss:
587.2585
Epoch: 026/050 | Batch 0200/0636 | Loss:
575.9724
Epoch: 026/050 | Batch 0250/0636 | Loss:
573.8395
Epoch: 026/050 | Batch 0300/0636 | Loss:
591.6125
Epoch: 026/050 | Batch 0350/0636 | Loss:
576.3284
Epoch: 026/050 | Batch 0400/0636 | Loss:
579.3765
Epoch: 026/050 | Batch 0450/0636 | Loss:
582.3946
Epoch: 026/050 | Batch 0500/0636 | Loss:
563.7219
Epoch: 026/050 | Batch 0550/0636 | Loss:
596.4344
Epoch: 026/050 | Batch 0600/0636 | Loss:
572.3001
Time elapsed: 42.52 min
Epoch: 027/050 | Batch 0000/0636 | Loss:
602.8784
Epoch: 027/050 | Batch 0050/0636 | Loss:
573.7595
Epoch: 027/050 | Batch 0100/0636 | Loss:
583.6584
Epoch: 027/050 | Batch 0150/0636 | Loss:
566.6611
Epoch: 027/050 | Batch 0200/0636 | Loss:
556.9034
Epoch: 027/050 | Batch 0250/0636 | Loss:
590.1951
Epoch: 027/050 | Batch 0300/0636 | Loss:
569.3027
Epoch: 027/050 | Batch 0350/0636 | Loss:
567.9160
Epoch: 027/050 | Batch 0400/0636 | Loss:
593.9990
Epoch: 027/050 | Batch 0450/0636 | Loss:

Epoch: 027/050 | Batch 0450/0636 | Loss: 576.1722
Epoch: 027/050 | Batch 0500/0636 | Loss: 574.7310
Epoch: 027/050 | Batch 0550/0636 | Loss: 588.2480
Epoch: 027/050 | Batch 0600/0636 | Loss: 564.8317
Time elapsed: 44.12 min
Epoch: 028/050 | Batch 0000/0636 | Loss: 567.0582
Epoch: 028/050 | Batch 0050/0636 | Loss: 581.8660
Epoch: 028/050 | Batch 0100/0636 | Loss: 587.7371
Epoch: 028/050 | Batch 0150/0636 | Loss: 560.2366
Epoch: 028/050 | Batch 0200/0636 | Loss: 569.6622
Epoch: 028/050 | Batch 0250/0636 | Loss: 567.1794
Epoch: 028/050 | Batch 0300/0636 | Loss: 573.6835
Epoch: 028/050 | Batch 0350/0636 | Loss: 557.9620
Epoch: 028/050 | Batch 0400/0636 | Loss: 547.5524
Epoch: 028/050 | Batch 0450/0636 | Loss: 591.2034
Epoch: 028/050 | Batch 0500/0636 | Loss: 566.1294
Epoch: 028/050 | Batch 0550/0636 | Loss: 585.2023
Epoch: 028/050 | Batch 0600/0636 | Loss: 570.0541
Time elapsed: 45.74 min
Epoch: 029/050 | Batch 0000/0636 | Loss: 594.8350
Epoch: 029/050 | Batch 0050/0636 | Loss: 575.8929
Epoch: 029/050 | Batch 0100/0636 | Loss: 568.1672
Epoch: 029/050 | Batch 0150/0636 | Loss: 570.1934
Epoch: 029/050 | Batch 0200/0636 | Loss: 582.1040
Epoch: 029/050 | Batch 0250/0636 | Loss: 573.1107

Epoch: 029/050 | Batch 0250/0636 | Loss: 579.6487
Epoch: 029/050 | Batch 0300/0636 | Loss: 560.8041
Epoch: 029/050 | Batch 0350/0636 | Loss: 581.8209
Epoch: 029/050 | Batch 0400/0636 | Loss: 583.6737
Epoch: 029/050 | Batch 0450/0636 | Loss: 582.5168
Epoch: 029/050 | Batch 0500/0636 | Loss: 574.7248
Epoch: 029/050 | Batch 0550/0636 | Loss: 570.2842
Epoch: 029/050 | Batch 0600/0636 | Loss: 556.5154
Time elapsed: 47.34 min
Epoch: 030/050 | Batch 0000/0636 | Loss: 587.7455
Epoch: 030/050 | Batch 0050/0636 | Loss: 587.0443
Epoch: 030/050 | Batch 0100/0636 | Loss: 571.6075
Epoch: 030/050 | Batch 0150/0636 | Loss: 565.5320
Epoch: 030/050 | Batch 0200/0636 | Loss: 577.8975
Epoch: 030/050 | Batch 0250/0636 | Loss: 574.7066
Epoch: 030/050 | Batch 0300/0636 | Loss: 567.2550
Epoch: 030/050 | Batch 0350/0636 | Loss: 594.2842
Epoch: 030/050 | Batch 0400/0636 | Loss: 586.4973
Epoch: 030/050 | Batch 0450/0636 | Loss: 565.0685
Epoch: 030/050 | Batch 0500/0636 | Loss: 563.3840
Epoch: 030/050 | Batch 0550/0636 | Loss: 576.9675
Epoch: 030/050 | Batch 0600/0636 | Loss: 573.4100
Time elapsed: 49.09 min
Epoch: 031/050 | Batch 0000/0636 | Loss: 607.7975
Epoch: 031/050 | Batch 0050/0636 | Loss:

Epoch: 031/050 | Batch 0000/0636 | Loss: 607.7975
Epoch: 031/050 | Batch 0050/0636 | Loss: 542.8645
Epoch: 031/050 | Batch 0100/0636 | Loss: 581.2004
Epoch: 031/050 | Batch 0150/0636 | Loss: 562.1296
Epoch: 031/050 | Batch 0200/0636 | Loss: 559.7120
Epoch: 031/050 | Batch 0250/0636 | Loss: 572.4832
Epoch: 031/050 | Batch 0300/0636 | Loss: 572.1790
Epoch: 031/050 | Batch 0350/0636 | Loss: 569.8812
Epoch: 031/050 | Batch 0400/0636 | Loss: 589.0427
Epoch: 031/050 | Batch 0450/0636 | Loss: 605.8442
Epoch: 031/050 | Batch 0500/0636 | Loss: 550.6684
Epoch: 031/050 | Batch 0550/0636 | Loss: 557.1177
Epoch: 031/050 | Batch 0600/0636 | Loss: 576.6524
Time elapsed: 50.84 min
Epoch: 032/050 | Batch 0000/0636 | Loss: 565.8171
Epoch: 032/050 | Batch 0050/0636 | Loss: 573.6804
Epoch: 032/050 | Batch 0100/0636 | Loss: 564.8236
Epoch: 032/050 | Batch 0150/0636 | Loss: 572.9670
Epoch: 032/050 | Batch 0200/0636 | Loss: 564.3489
Epoch: 032/050 | Batch 0250/0636 | Loss: 587.4039
Epoch: 032/050 | Batch 0300/0636 | Loss: 566.5675
Epoch: 032/050 | Batch 0350/0636 | Loss: 593.6508
Epoch: 032/050 | Batch 0400/0636 | Loss: 549.3412
Epoch: 032/050 | Batch 0450/0636 | Loss: 552.8627
Epoch: 032/050 | Batch 0500/0636 | Loss: 569.5948
Epoch: 032/050 | Batch 0550/0636 | Loss: 552.6619
Epoch: 032/050 | Batch 0600/0636 | Loss: 563.3416

Epoch: 032/050 | Batch 0600/0636 | Loss: 563.3416
Time elapsed: 52.44 min
Epoch: 033/050 | Batch 0000/0636 | Loss: 572.5204
Epoch: 033/050 | Batch 0050/0636 | Loss: 534.1483
Epoch: 033/050 | Batch 0100/0636 | Loss: 569.4390
Epoch: 033/050 | Batch 0150/0636 | Loss: 585.1000
Epoch: 033/050 | Batch 0200/0636 | Loss: 572.4746
Epoch: 033/050 | Batch 0250/0636 | Loss: 566.2021
Epoch: 033/050 | Batch 0300/0636 | Loss: 567.0029
Epoch: 033/050 | Batch 0350/0636 | Loss: 561.7045
Epoch: 033/050 | Batch 0400/0636 | Loss: 565.2118
Epoch: 033/050 | Batch 0450/0636 | Loss: 577.8336
Epoch: 033/050 | Batch 0500/0636 | Loss: 551.5012
Epoch: 033/050 | Batch 0550/0636 | Loss: 566.4229
Epoch: 033/050 | Batch 0600/0636 | Loss: 566.3771
Time elapsed: 54.11 min
Epoch: 034/050 | Batch 0000/0636 | Loss: 551.5951
Epoch: 034/050 | Batch 0050/0636 | Loss: 571.3142
Epoch: 034/050 | Batch 0100/0636 | Loss: 576.3873
Epoch: 034/050 | Batch 0150/0636 | Loss: 580.7638
Epoch: 034/050 | Batch 0200/0636 | Loss: 582.3458
Epoch: 034/050 | Batch 0250/0636 | Loss: 567.6672
Epoch: 034/050 | Batch 0300/0636 | Loss: 554.6337
Epoch: 034/050 | Batch 0350/0636 | Loss: 559.4736
Epoch: 034/050 | Batch 0400/0636 | Loss: 580.7354
Epoch: 034/050 | Batch 0450/0636 | Loss: 572.0772

Epoch: 034/050 | Batch 0500/0636 | Loss: 586.1283
Epoch: 034/050 | Batch 0550/0636 | Loss: 553.9575
Epoch: 034/050 | Batch 0600/0636 | Loss: 572.4213
Time elapsed: 55.71 min
Epoch: 035/050 | Batch 0000/0636 | Loss: 568.6148
Epoch: 035/050 | Batch 0050/0636 | Loss: 565.2618
Epoch: 035/050 | Batch 0100/0636 | Loss: 588.9366
Epoch: 035/050 | Batch 0150/0636 | Loss: 548.4774
Epoch: 035/050 | Batch 0200/0636 | Loss: 552.0162
Epoch: 035/050 | Batch 0250/0636 | Loss: 558.4570
Epoch: 035/050 | Batch 0300/0636 | Loss: 574.5162
Epoch: 035/050 | Batch 0350/0636 | Loss: 575.8137
Epoch: 035/050 | Batch 0400/0636 | Loss: 583.9932
Epoch: 035/050 | Batch 0450/0636 | Loss: 598.4695
Epoch: 035/050 | Batch 0500/0636 | Loss: 561.1655
Epoch: 035/050 | Batch 0550/0636 | Loss: 554.1101
Epoch: 035/050 | Batch 0600/0636 | Loss: 582.9425
Time elapsed: 57.37 min
Epoch: 036/050 | Batch 0000/0636 | Loss: 566.4686
Epoch: 036/050 | Batch 0050/0636 | Loss: 551.5837
Epoch: 036/050 | Batch 0100/0636 | Loss: 590.4393
Epoch: 036/050 | Batch 0150/0636 | Loss: 556.5223
Epoch: 036/050 | Batch 0200/0636 | Loss: 604.1888
Epoch: 036/050 | Batch 0250/0636 | Loss: 569.0227
Epoch: 036/050 | Batch 0300/0636 | Loss: 587.5238
Epoch: 036/050 | Batch 0350/0636 | Loss: 573.3497

568.6552
Epoch: 036/050 | Batch 0450/0636 | Loss:
566.9286
Epoch: 036/050 | Batch 0500/0636 | Loss:
575.9884
Epoch: 036/050 | Batch 0550/0636 | Loss:
564.3260
Epoch: 036/050 | Batch 0600/0636 | Loss:
564.7509
Time elapsed: 59.11 min
Epoch: 037/050 | Batch 0000/0636 | Loss:
578.1541
Epoch: 037/050 | Batch 0050/0636 | Loss:
566.8448
Epoch: 037/050 | Batch 0100/0636 | Loss:
564.6245
Epoch: 037/050 | Batch 0150/0636 | Loss:
543.3318
Epoch: 037/050 | Batch 0200/0636 | Loss:
585.8563
Epoch: 037/050 | Batch 0250/0636 | Loss:
550.9480
Epoch: 037/050 | Batch 0300/0636 | Loss:
566.6594
Epoch: 037/050 | Batch 0350/0636 | Loss:
552.8662
Epoch: 037/050 | Batch 0400/0636 | Loss:
578.4430
Epoch: 037/050 | Batch 0450/0636 | Loss:
559.7460
Epoch: 037/050 | Batch 0500/0636 | Loss:
558.5486
Epoch: 037/050 | Batch 0550/0636 | Loss:
560.9149
Epoch: 037/050 | Batch 0600/0636 | Loss:
554.5380
Time elapsed: 60.75 min
Epoch: 038/050 | Batch 0000/0636 | Loss:
576.2805
Epoch: 038/050 | Batch 0050/0636 | Loss:
601.5486
Epoch: 038/050 | Batch 0100/0636 | Loss:
556.2235
Epoch: 038/050 | Batch 0150/0636 | Loss:
554.6494
Epoch: 038/050 | Batch 0200/0636 | Loss:
578.1447

Epoch: 038/050 | Batch 0250/0636 | Loss: 563.8064
Epoch: 038/050 | Batch 0300/0636 | Loss: 576.9979
Epoch: 038/050 | Batch 0350/0636 | Loss: 562.5789
Epoch: 038/050 | Batch 0400/0636 | Loss: 567.5704
Epoch: 038/050 | Batch 0450/0636 | Loss: 579.3035
Epoch: 038/050 | Batch 0500/0636 | Loss: 565.7397
Epoch: 038/050 | Batch 0550/0636 | Loss: 558.0376
Epoch: 038/050 | Batch 0600/0636 | Loss: 558.7964
Time elapsed: 62.37 min
Epoch: 039/050 | Batch 0000/0636 | Loss: 581.2038
Epoch: 039/050 | Batch 0050/0636 | Loss: 558.0044
Epoch: 039/050 | Batch 0100/0636 | Loss: 577.2795
Epoch: 039/050 | Batch 0150/0636 | Loss: 564.0444
Epoch: 039/050 | Batch 0200/0636 | Loss: 557.1873
Epoch: 039/050 | Batch 0250/0636 | Loss: 604.9391
Epoch: 039/050 | Batch 0300/0636 | Loss: 578.8990
Epoch: 039/050 | Batch 0350/0636 | Loss: 565.5298
Epoch: 039/050 | Batch 0400/0636 | Loss: 583.5161
Epoch: 039/050 | Batch 0450/0636 | Loss: 554.2496
Epoch: 039/050 | Batch 0500/0636 | Loss: 572.1195
Epoch: 039/050 | Batch 0550/0636 | Loss: 564.6726
Epoch: 039/050 | Batch 0600/0636 | Loss: 572.7513
Time elapsed: 63.97 min
Epoch: 040/050 | Batch 0000/0636 | Loss: 571.1583
Epoch: 040/050 | Batch 0050/0636 | Loss: 582.7159

Epoch: 040/050 | Batch 0050/0636 | Loss: 583.7159
Epoch: 040/050 | Batch 0100/0636 | Loss: 573.6093
Epoch: 040/050 | Batch 0150/0636 | Loss: 582.2701
Epoch: 040/050 | Batch 0200/0636 | Loss: 568.4056
Epoch: 040/050 | Batch 0250/0636 | Loss: 575.5870
Epoch: 040/050 | Batch 0300/0636 | Loss: 579.0773
Epoch: 040/050 | Batch 0350/0636 | Loss: 572.6606
Epoch: 040/050 | Batch 0400/0636 | Loss: 575.1016
Epoch: 040/050 | Batch 0450/0636 | Loss: 578.7159
Epoch: 040/050 | Batch 0500/0636 | Loss: 572.6605
Epoch: 040/050 | Batch 0550/0636 | Loss: 581.2191
Epoch: 040/050 | Batch 0600/0636 | Loss: 568.9755
Time elapsed: 65.70 min
Epoch: 041/050 | Batch 0000/0636 | Loss: 560.6986
Epoch: 041/050 | Batch 0050/0636 | Loss: 555.5684
Epoch: 041/050 | Batch 0100/0636 | Loss: 568.6328
Epoch: 041/050 | Batch 0150/0636 | Loss: 555.0646
Epoch: 041/050 | Batch 0200/0636 | Loss: 562.9788
Epoch: 041/050 | Batch 0250/0636 | Loss: 569.6073
Epoch: 041/050 | Batch 0300/0636 | Loss: 581.8447
Epoch: 041/050 | Batch 0350/0636 | Loss: 553.8451
Epoch: 041/050 | Batch 0400/0636 | Loss: 565.2787
Epoch: 041/050 | Batch 0450/0636 | Loss: 551.6981
Epoch: 041/050 | Batch 0500/0636 | Loss: 566.5472

566.5472
Epoch: 041/050 | Batch 0550/0636 | Loss:
593.4119
Epoch: 041/050 | Batch 0600/0636 | Loss:
552.6426
Time elapsed: 67.36 min
Epoch: 042/050 | Batch 0000/0636 | Loss:
558.3716
Epoch: 042/050 | Batch 0050/0636 | Loss:
574.7903
Epoch: 042/050 | Batch 0100/0636 | Loss:
571.2197
Epoch: 042/050 | Batch 0150/0636 | Loss:
581.6074
Epoch: 042/050 | Batch 0200/0636 | Loss:
554.7395
Epoch: 042/050 | Batch 0250/0636 | Loss:
562.5910
Epoch: 042/050 | Batch 0300/0636 | Loss:
581.4440
Epoch: 042/050 | Batch 0350/0636 | Loss:
548.7981
Epoch: 042/050 | Batch 0400/0636 | Loss:
568.4072
Epoch: 042/050 | Batch 0450/0636 | Loss:
572.7113
Epoch: 042/050 | Batch 0500/0636 | Loss:
557.3634
Epoch: 042/050 | Batch 0550/0636 | Loss:
563.5954
Epoch: 042/050 | Batch 0600/0636 | Loss:
558.3805
Time elapsed: 69.00 min
Epoch: 043/050 | Batch 0000/0636 | Loss:
556.0875
Epoch: 043/050 | Batch 0050/0636 | Loss:
562.2979
Epoch: 043/050 | Batch 0100/0636 | Loss:
572.7736
Epoch: 043/050 | Batch 0150/0636 | Loss:
578.6178
Epoch: 043/050 | Batch 0200/0636 | Loss:
561.4854
Epoch: 043/050 | Batch 0250/0636 | Loss:
582.3480
Epoch: 043/050 | Batch 0300/0636 | Loss:
559.3983

559.3983
Epoch: 043/050 | Batch 0350/0636 | Loss:
547.6210
Epoch: 043/050 | Batch 0400/0636 | Loss:
591.8817
Epoch: 043/050 | Batch 0450/0636 | Loss:
551.5429
Epoch: 043/050 | Batch 0500/0636 | Loss:
556.2452
Epoch: 043/050 | Batch 0550/0636 | Loss:
561.8329
Epoch: 043/050 | Batch 0600/0636 | Loss:
586.5648
Time elapsed: 70.61 min
Epoch: 044/050 | Batch 0000/0636 | Loss:
564.7667
Epoch: 044/050 | Batch 0050/0636 | Loss:
564.6843
Epoch: 044/050 | Batch 0100/0636 | Loss:
555.3098
Epoch: 044/050 | Batch 0150/0636 | Loss:
550.7322
Epoch: 044/050 | Batch 0200/0636 | Loss:
566.9087
Epoch: 044/050 | Batch 0250/0636 | Loss:
558.0258
Epoch: 044/050 | Batch 0300/0636 | Loss:
585.2075
Epoch: 044/050 | Batch 0350/0636 | Loss:
547.1914
Epoch: 044/050 | Batch 0400/0636 | Loss:
564.2390
Epoch: 044/050 | Batch 0450/0636 | Loss:
566.4260
Epoch: 044/050 | Batch 0500/0636 | Loss:
576.3375
Epoch: 044/050 | Batch 0550/0636 | Loss:
572.2164
Epoch: 044/050 | Batch 0600/0636 | Loss:
557.8451
Time elapsed: 72.27 min
Epoch: 045/050 | Batch 0000/0636 | Loss:
567.9696
Epoch: 045/050 | Batch 0050/0636 | Loss:
549.8677
Epoch: 045/050 | Batch 0100/0636 | Loss:
584.3383

Epoch: 045/050 | Batch 0200/0636 | Loss: 562.9568
Epoch: 045/050 | Batch 0250/0636 | Loss: 552.1664
Epoch: 045/050 | Batch 0300/0636 | Loss: 569.3069
Epoch: 045/050 | Batch 0350/0636 | Loss: 589.8751
Epoch: 045/050 | Batch 0400/0636 | Loss: 567.7795
Epoch: 045/050 | Batch 0450/0636 | Loss: 546.2745
Epoch: 045/050 | Batch 0500/0636 | Loss: 583.3383
Epoch: 045/050 | Batch 0550/0636 | Loss: 571.5374
Epoch: 045/050 | Batch 0600/0636 | Loss: 573.9012
Time elapsed: 73.92 min
Epoch: 046/050 | Batch 0000/0636 | Loss: 557.4848
Epoch: 046/050 | Batch 0050/0636 | Loss: 557.9838
Epoch: 046/050 | Batch 0100/0636 | Loss: 564.4703
Epoch: 046/050 | Batch 0150/0636 | Loss: 598.5457
Epoch: 046/050 | Batch 0200/0636 | Loss: 550.8486
Epoch: 046/050 | Batch 0250/0636 | Loss: 571.9793
Epoch: 046/050 | Batch 0300/0636 | Loss: 557.2795
Epoch: 046/050 | Batch 0350/0636 | Loss: 559.4592
Epoch: 046/050 | Batch 0400/0636 | Loss: 600.5262
Epoch: 046/050 | Batch 0450/0636 | Loss: 553.5612
Epoch: 046/050 | Batch 0500/0636 | Loss: 573.6791
Epoch: 046/050 | Batch 0550/0636 | Loss: 559.9025
Epoch: 046/050 | Batch 0600/0636 | Loss: 566.4237
Time elapsed: 75.52 min
Epoch: 047/050 | Batch 0000/0636 | Loss:

561.7014
Epoch: 047/050 | Batch 0050/0636 | Loss:
581.5356
Epoch: 047/050 | Batch 0100/0636 | Loss:
555.9092
Epoch: 047/050 | Batch 0150/0636 | Loss:
562.5129
Epoch: 047/050 | Batch 0200/0636 | Loss:
572.0879
Epoch: 047/050 | Batch 0250/0636 | Loss:
546.0706
Epoch: 047/050 | Batch 0300/0636 | Loss:
558.0298
Epoch: 047/050 | Batch 0350/0636 | Loss:
565.5862
Epoch: 047/050 | Batch 0400/0636 | Loss:
590.1718
Epoch: 047/050 | Batch 0450/0636 | Loss:
568.8922
Epoch: 047/050 | Batch 0500/0636 | Loss:
581.7423
Epoch: 047/050 | Batch 0550/0636 | Loss:
552.8250
Epoch: 047/050 | Batch 0600/0636 | Loss:
549.6586
Time elapsed: 77.13 min
Epoch: 048/050 | Batch 0000/0636 | Loss:
551.9084
Epoch: 048/050 | Batch 0050/0636 | Loss:
544.2269
Epoch: 048/050 | Batch 0100/0636 | Loss:
568.6279
Epoch: 048/050 | Batch 0150/0636 | Loss:
556.5679
Epoch: 048/050 | Batch 0200/0636 | Loss:
569.7594
Epoch: 048/050 | Batch 0250/0636 | Loss:
546.5939
Epoch: 048/050 | Batch 0300/0636 | Loss:
576.5042
Epoch: 048/050 | Batch 0350/0636 | Loss:
554.6760
Epoch: 048/050 | Batch 0400/0636 | Loss:
541.3717
Epoch: 048/050 | Batch 0450/0636 | Loss:
569.5439
Epoch: 048/050 | Batch 0500/0636 | Loss:

578.5395
Epoch: 048/050 | Batch 0600/0636 | Loss:
559.0204
Time elapsed: 78.80 min
Epoch: 049/050 | Batch 0000/0636 | Loss:
581.8534
Epoch: 049/050 | Batch 0050/0636 | Loss:
543.4080
Epoch: 049/050 | Batch 0100/0636 | Loss:
557.5757
Epoch: 049/050 | Batch 0150/0636 | Loss:
587.8804
Epoch: 049/050 | Batch 0200/0636 | Loss:
559.3380
Epoch: 049/050 | Batch 0250/0636 | Loss:
567.7843
Epoch: 049/050 | Batch 0300/0636 | Loss:
594.4500
Epoch: 049/050 | Batch 0350/0636 | Loss:
530.3146
Epoch: 049/050 | Batch 0400/0636 | Loss:
560.1475
Epoch: 049/050 | Batch 0450/0636 | Loss:
563.2232
Epoch: 049/050 | Batch 0500/0636 | Loss:
563.5891
Epoch: 049/050 | Batch 0550/0636 | Loss:
560.6351
Epoch: 049/050 | Batch 0600/0636 | Loss:
557.8743
Time elapsed: 80.41 min
Epoch: 050/050 | Batch 0000/0636 | Loss:
541.5349
Epoch: 050/050 | Batch 0050/0636 | Loss:
586.1244
Epoch: 050/050 | Batch 0100/0636 | Loss:
551.7889
Epoch: 050/050 | Batch 0150/0636 | Loss:
567.9817
Epoch: 050/050 | Batch 0200/0636 | Loss:
573.9722
Epoch: 050/050 | Batch 0250/0636 | Loss:
554.6897
Epoch: 050/050 | Batch 0300/0636 | Loss:
557.8098
Epoch: 050/050 | Batch 0350/0636 | Loss:
552.7642

559.5580
Epoch: 049/050 | Batch 0250/0636 | Loss: 567.7843
Epoch: 049/050 | Batch 0300/0636 | Loss: 594.4500
Epoch: 049/050 | Batch 0350/0636 | Loss: 530.3146
Epoch: 049/050 | Batch 0400/0636 | Loss: 560.1475
Epoch: 049/050 | Batch 0450/0636 | Loss: 563.2232
Epoch: 049/050 | Batch 0500/0636 | Loss: 563.5891
Epoch: 049/050 | Batch 0550/0636 | Loss: 560.6351
Epoch: 049/050 | Batch 0600/0636 | Loss: 557.8743
Time elapsed: 80.41 min
Epoch: 050/050 | Batch 0000/0636 | Loss: 541.5349
Epoch: 050/050 | Batch 0050/0636 | Loss: 586.1244
Epoch: 050/050 | Batch 0100/0636 | Loss: 551.7889
Epoch: 050/050 | Batch 0150/0636 | Loss: 567.9817
Epoch: 050/050 | Batch 0200/0636 | Loss: 573.9722
Epoch: 050/050 | Batch 0250/0636 | Loss: 554.6897
Epoch: 050/050 | Batch 0300/0636 | Loss: 557.8098
Epoch: 050/050 | Batch 0350/0636 | Loss: 552.7642
Epoch: 050/050 | Batch 0400/0636 | Loss: 551.5117
Epoch: 050/050 | Batch 0450/0636 | Loss: 558.1167
Epoch: 050/050 | Batch 0500/0636 | Loss: 561.1556
Epoch: 050/050 | Batch 0550/0636 | Loss: 557.0878
Epoch: 050/050 | Batch 0600/0636 | Loss: 570.8301
Time elapsed: 82.04 min
Total Training Time: 82.04 min

In [12]:

```
#unnormalizer = UnNormalize((0.5, 0.5, 0
plot_generated_images(data_loader=train_
    model=model,
    #unnormalizer=unno.
    device=DEVICE,
    modeltype='VAE')
```



In [13]:

```
for i in range(10):
    plot_images_sampled_from_vae(model=model)
    plt.show()
```

