FashionMNIST VAE

In [1]:
```
import matplotlib.pyplot as plt
%matplotlib inline

import numpy as np
import torch
import torchvision
import torchvision.transforms as tvt
import pyro
from pyro.infer import SVI, Trace_ELBO
from pyro.optim import Adam, Adamax, Adadelta, SGD, RMSprop
from torchvision import utils
from helper_functions import *
from sklearn.manifold import TSNE
from PIL import Image
```

Define the simulation parameters

In [2]:
```
params = {
    'CHANNELS' : 1,
    'WIDTH' : 28,
    'HEIGHT':28,
    'DIM_Z':20,
    'SCALE': 1.0,
    'use_cuda' : torch.cuda.is_available()
    }
print(params)
```

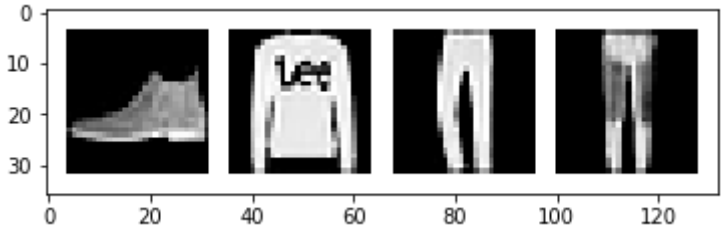
```
{'CHANNELS': 1, 'use_cuda': True, 'WIDTH': 28, 'SCALE': 1.0, 'DIM_Z': 2
0, 'HEIGHT': 28}
```

Get the data

In [3]:
```
BATCH_SIZE = 512
kwargs = {'num_workers': 0, 'pin_memory': params["use_cuda"]}
data_dir = "/home/jupyter/REPOS/VAE_PYRO"
#data_dir = "/home/ldalessi/REPOS/VAE_PYRO"
#data_dir = "/Users/ldalessi/VAE_PYRO"


trainset = torchvision.datasets.FashionMNIST(data_dir, train=True, downl
oad=True, transform=tvt.ToTensor())
trainloader = torch.utils.data.DataLoader(trainset, batch_size=BATCH_SIZ
E, shuffle=True, **kwargs)
testset = torchvision.datasets.FashionMNIST(data_dir, train=False, downl
oad=True, transform=tvt.ToTensor())
testloader = torch.utils.data.DataLoader(testset, batch_size=BATCH_SIZE,
shuffle=False, **kwargs)

imgs_test,labels = next(iter(testloader))
if(params['use_cuda']):
    imgs_test=imgs_test[:4].cuda()

print(imgs_test.shape)
show_batch(imgs_test,npadding=4)
```

```
torch.Size([4, 1, 28, 28])
```

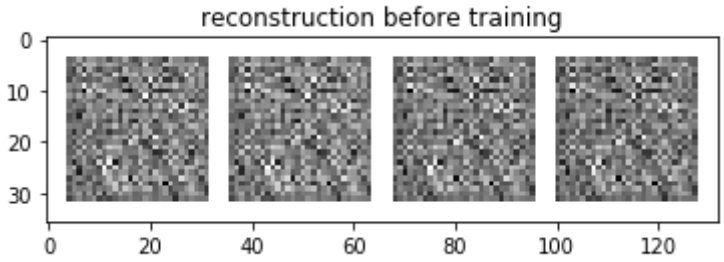
Out[3]:
```
<matplotlib.image.AxesImage at 0x7fc291629198>
```



VAE in PYTORCH

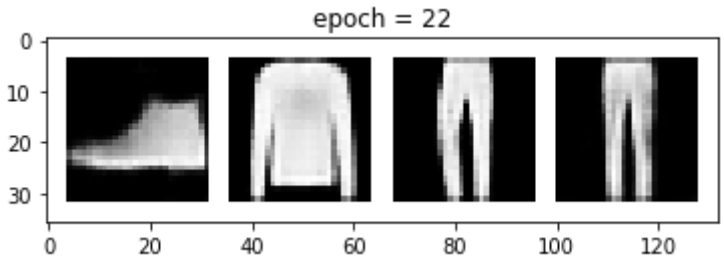
In [4]:
```
from encoder_decoder import *
from vae import *
encoder = Encoder_CONV(params)
decoder = Decoder_CONV(params)
vae = VAE(params,encoder,decoder)
```

In [5]:
```
imgs_rec = vae.reconstruct(imgs_test)
show_batch(imgs_rec,nrow=4,npadding=4,title="reconstruction before train
ing")
plt.savefig("rec_before_training_g_1.5.png")
```



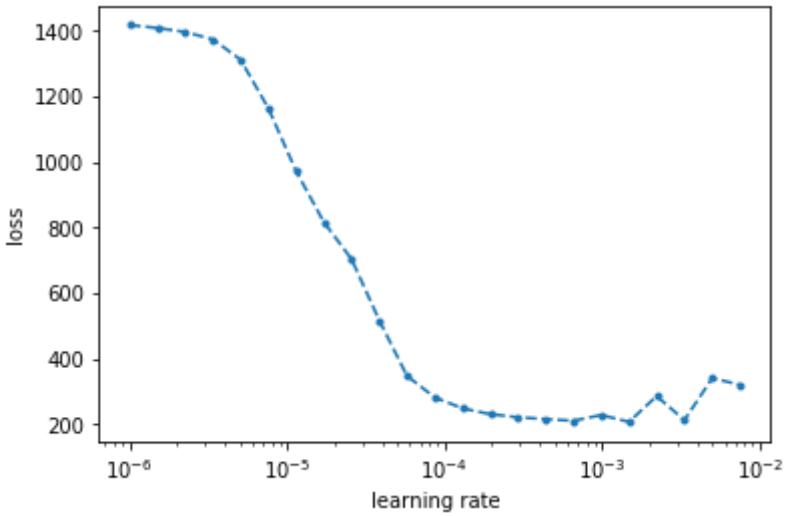
In [6]:
```
pt_optimizer = torch.optim.RMSprop(vae.parameters(),lr=1E-6)
pt_scheduler = torch.optim.lr_scheduler.StepLR(pt_optimizer, step_size=1
, gamma=1.5, last_epoch=-1)

pt_hist_loss = []
pt_hist_lr = []
for epoch in range(30):
    loss_curr = train_VAE_pytorch(vae, trainloader, pt_optimizer, use_cu
da = params['use_cuda'], verbose=(epoch==-1))
    lr_curr   = pt_optimizer.param_groups[0]['lr']
    print("[epoch %03d] train loss: %.4f lr: %.4e" % (epoch, loss_curr,
lr_curr))
    pt_hist_loss.append(loss_curr)
    pt_hist_lr.append(lr_curr)
    pt_scheduler.step()
    if(np.isnan(loss_curr)):
        break

    imgs_rec = vae.reconstruct(imgs_test)
    show_batch(imgs_rec,nrow=4,npadding=4,title="epoch = "+str(epoch))
    plt.savefig("PYTORCH_rec_epoch_g_1.5_"+str(epoch)+".png")
```

```
[epoch 000] train loss: 1418.2442 lr: 1.0000e-06
[epoch 001] train loss: 1409.2605 lr: 1.5000e-06
[epoch 002] train loss: 1397.0396 lr: 2.2500e-06
[epoch 003] train loss: 1374.5964 lr: 3.3750e-06
[epoch 004] train loss: 1312.4497 lr: 5.0625e-06
[epoch 005] train loss: 1164.4697 lr: 7.5937e-06
[epoch 006] train loss: 972.7137 lr: 1.1391e-05
[epoch 007] train loss: 817.3457 lr: 1.7086e-05
[epoch 008] train loss: 704.2495 lr: 2.5629e-05
[epoch 009] train loss: 517.3660 lr: 3.8443e-05
[epoch 010] train loss: 348.0044 lr: 5.7665e-05
[epoch 011] train loss: 282.7686 lr: 8.6498e-05
[epoch 012] train loss: 249.2594 lr: 1.2975e-04
[epoch 013] train loss: 231.6670 lr: 1.9462e-04
[epoch 014] train loss: 222.1175 lr: 2.9193e-04
[epoch 015] train loss: 216.4983 lr: 4.3789e-04
[epoch 016] train loss: 211.4841 lr: 6.5684e-04
[epoch 017] train loss: 228.8647 lr: 9.8526e-04
[epoch 018] train loss: 208.1706 lr: 1.4779e-03
[epoch 019] train loss: 286.5614 lr: 2.2168e-03
[epoch 020] train loss: 213.4607 lr: 3.3253e-03
[epoch 021] train loss: 341.1946 lr: 4.9879e-03
[epoch 022] train loss: 321.5406 lr: 7.4818e-03
[epoch 023] train loss: nan lr: 1.1223e-02
```

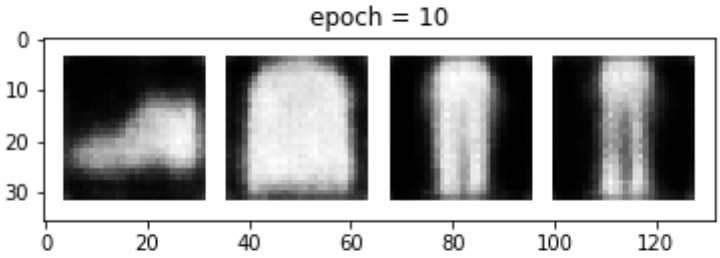


Show pytorch results

In [8]:
```
plt.xscale('log')
plt.plot(pt_hist_lr,pt_hist_loss,'.--')
plt.xlabel('learning rate')
plt.ylabel('loss')
plt.savefig("PYTORCH_train_g_1.5.png")
```



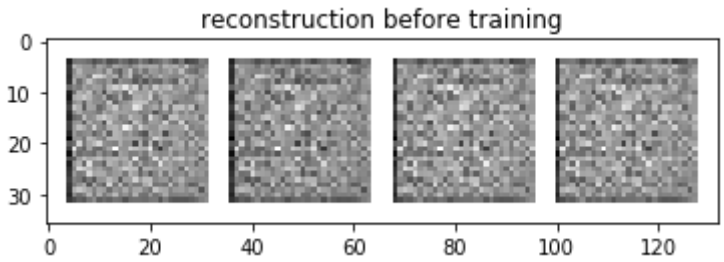
In [9]:
```
#intermediate reconstrucxtion
epoch = 10
path="./PYTORCH_rec_epoch_g_1.5_"+str(epoch)+".png"
display(Image.open(path))
```



VAE in PYRO

In [10]:
```
from encoder_decoder import *
from vae import *
encoder = Encoder_CONV(params)
decoder = Decoder_CONV(params)
vae = VAE(params,encoder,decoder)
```

In [11]:
```
imgs_rec = vae.reconstruct(imgs_test)
show_batch(imgs_rec,nrow=4,npadding=4,title="reconstruction before train
ing")
plt.savefig("rec_before_training_g_1.5.png")
```



In [14]:
```
pyro.clear_param_store()
pyro.set_rng_seed(0)

optimizer_args = {'lr': 1E-6}
scheduler_args = {'optimizer': torch.optim.RMSprop, 'step_size' : 1, 'ga
mma' : 1.5, 'optim_args' : optimizer_args}

pyro_scheduler = pyro.optim.StepLR(scheduler_args)
svi = SVI(vae.model, vae.guide, pyro_scheduler, loss=Trace_ELBO(num_part
icles=1))

pr_hist_loss = []
pr_hist_lr = []

for epoch in range(0,30):

    loss_curr = train(svi, trainloader, use_cuda=params['use_cuda'], ver
bose=False)
    lr_curr   = pyro_scheduler.pt_optim_args['lr']
    print("[epoch %03d] train loss: %.4f lr: %.4e" % (epoch, loss_curr,
lr_curr))
    pr_hist_loss.append(loss_curr)
    pr_hist_lr.append(lr_curr)
    if(np.isnan(loss_curr)):
        break

    imgs_rec = vae.reconstruct(imgs_test)
    show_batch(imgs_rec,nrow=4,npadding=4,title="epoch = "+str(epoch))
    plt.savefig("PYRO_rec_epoch_g_1.5_"+str(epoch)+".png")
```

```
/home/jupyter/.local/lib/python3.5/site-packages/pyro/infer/trace_elbo.
py:138: UserWarning: Encountered NaN: loss
  warn_if_nan(loss, "loss")
/home/jupyter/.local/lib/python3.5/site-packages/pyro/infer/trace_elbo.
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py:138: UserWarning: Encountered NaN: loss
  warn_if_nan(loss, "loss")
```

```
---------------------------------------------------------------------
----
KeyboardInterrupt                         Traceback (most recent call l
ast)
<ipython-input-14-790435680377> in <module>
     13 for epoch in range(0,30):
     14
---> 15     loss_curr = train(svi, trainloader, use_cuda=params['use_cu
da'], verbose=False)
     16     lr_curr   = pyro_scheduler.pt_optim_args['lr']
     17     print("[epoch %03d] train loss: %.4f lr: %.4e" % (epoch, lo
ss_curr, lr_curr))

~/REPOS/VAE_PYRO/helper_functions.py in train(svi, loader, use_cuda, ve
rbose)
     27 def train(svi, loader, use_cuda=False,verbose=False):
     28     epoch_loss = 0.
---> 29     for x, _ in loader:
     30         # if on GPU put mini-batch into CUDA memory
     31         if use_cuda:

~/.local/lib/python3.5/site-packages/torch/utils/data/dataloader.py in
__next__(self)
    558         if self.num_workers == 0:  # same-process loading
    559             indices = next(self.sample_iter)  # may raise StopI
teration
--> 560             batch = self.collate_fn([self.dataset[i] for i in i
ndices])
    561             if self.pin_memory:
    562                 batch = _utils.pin_memory.pin_memory_batch(batc
h)

~/.local/lib/python3.5/site-packages/torch/utils/data/dataloader.py in
<listcomp>(.0)
    558         if self.num_workers == 0:  # same-process loading
    559             indices = next(self.sample_iter)  # may raise StopI
teration
--> 560             batch = self.collate_fn([self.dataset[i] for i in i
ndices])
    561             if self.pin_memory:
    562                 batch = _utils.pin_memory.pin_memory_batch(batc
h)

~/.local/lib/python3.5/site-packages/torchvision/datasets/mnist.py in _
_getitem__(self, index)
     93
     94         if self.transform is not None:
---> 95             img = self.transform(img)
     96
     97         if self.target_transform is not None:

~/.local/lib/python3.5/site-packages/torchvision/transforms/transforms.
py in __call__(self, pic)
     90             Tensor: Converted image.
     91         """
---> 92         return F.to_tensor(pic)
     93
```

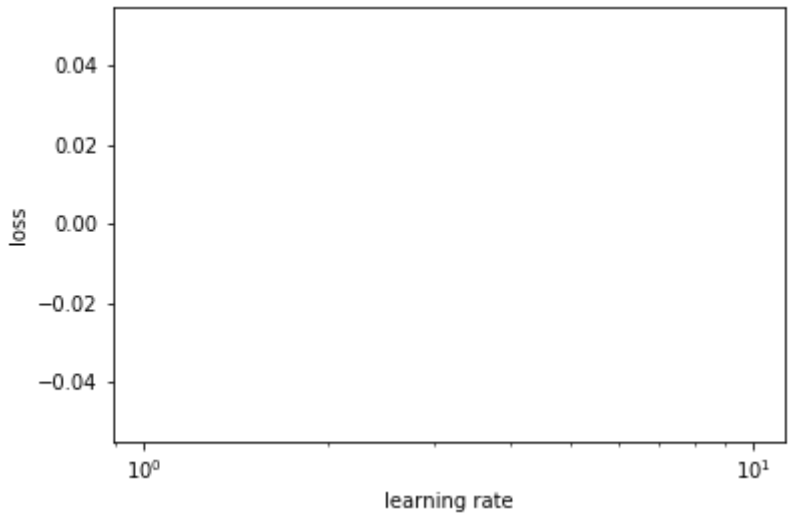
```
     94     def __repr__(self):

~/.local/lib/python3.5/site-packages/torchvision/transforms/functional.
py in to_tensor(pic)
     77         img = 255 * torch.from_numpy(np.array(pic, np.uint8, co
py=False))
     78     else:
---> 79         img = torch.ByteTensor(torch.ByteStorage.from_buffer(pi
c.tobytes()))
     80     # PIL image mode: L, LA, P, I, F, RGB, YCbCr, RGBA, CMYK
     81     if pic.mode == 'YCbCr':

KeyboardInterrupt:
```

Show PYRO results

In [15]:
```
plt.xscale('log')
plt.plot(pr_hist_lr,pr_hist_loss,'.--')
plt.xlabel('learning rate')
plt.ylabel('loss')
plt.savefig("PYRO_train_g_1.5.png")
```



In [16]:
```
epoch = 10
path="./PYRO_rec_epoch_g_1.5_"+str(epoch)+".png"
display(Image.open(path))
```

```
---------------------------------------------------------------------------
FileNotFoundError                         Traceback (most recent call l
ast)
<ipython-input-16-5759adeb2c01> in <module>
      1 epoch = 10
      2 path="./PYRO_rec_epoch_g_1.5_"+str(epoch)+".png"
----> 3 display(Image.open(path))

~/.local/lib/python3.5/site-packages/PIL/Image.py in open(fp, mode)
   2650
   2651     if filename:
-> 2652         fp = builtins.open(filename, "rb")
   2653         exclusive_fp = True
   2654

FileNotFoundError: [Errno 2] No such file or directory: './PYRO_rec_epo
ch_g_1.5_10.png'
```

In [ ]:
```

```