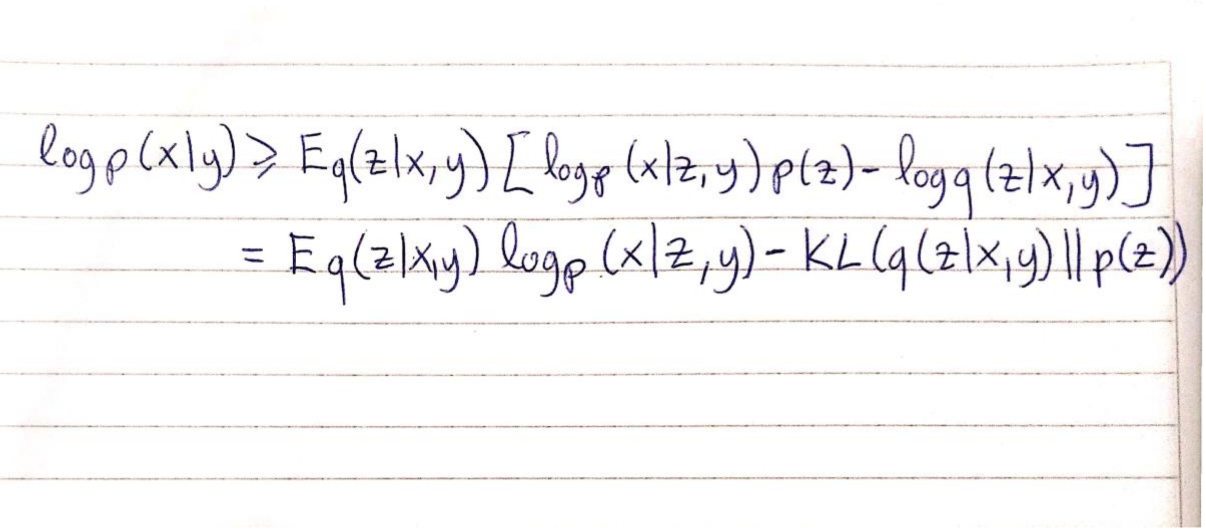
DL HW7 Student ID: 2019280513 Student Name: Sami Emre Erdogan

Class Conditional Variational Autoencoder on MNIST Homework 7

1. Following the variational Bayes algorithm of the original VAE, derive the algorithm for this class-conditional variant. Specifically, you need to design the variational distribution q(z|x, y) and write down the variational lower bound.



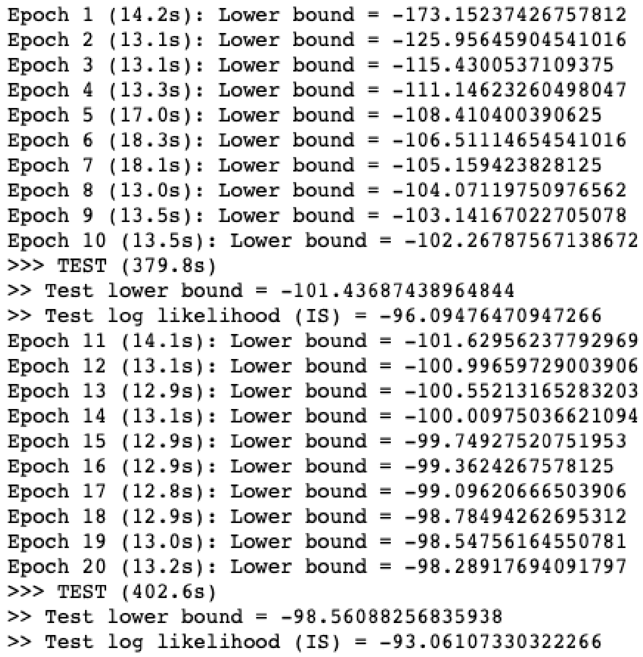
$$\log p(x|y) \geq E_{q(z|x,y)}\left[\log_p (x|z,y)\,p(z) - \log_q (z|x,y)\right]$$

$$= E_{q(z|x,y)} \log_p (x|z,y) - KL(q(z|x,y)\,||\,p(z))$$

2. Implement the algorithm using ZhuSuan, and train the model on the whole training set of MNIST.

I have referenced and implemented the code following the official ZhuSuan documentation guide. Check source code or HTML file for details.

output of test lower bound and Log Likelihood:



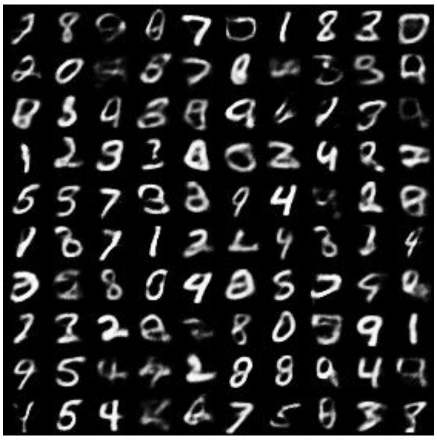
```
Epoch 1 (14.2s): Lower bound = -173.15237426757812
Epoch 2 (13.1s): Lower bound = -125.95645904541016
Epoch 3 (13.1s): Lower bound = -115.4300537109375
Epoch 4 (13.3s): Lower bound = -111.14623260498047
Epoch 5 (17.0s): Lower bound = -108.410400390625
Epoch 6 (18.3s): Lower bound = -106.51114654541016
Epoch 7 (18.1s): Lower bound = -105.159423828125
Epoch 8 (13.0s): Lower bound = -104.07119750976562
Epoch 9 (13.5s): Lower bound = -103.14167022705078
Epoch 10 (13.5s): Lower bound = -102.26787567138672
>>> TEST (379.8s)
>> Test lower bound = -101.43687438964844
>> Test log likelihood (IS) = -96.09476470947266
Epoch 11 (14.1s): Lower bound = -101.62956237792969
Epoch 12 (13.1s): Lower bound = -100.99659729003906
Epoch 13 (12.9s): Lower bound = -100.55213165283203
Epoch 14 (13.1s): Lower bound = -100.00975036621094
Epoch 15 (12.9s): Lower bound = -99.74927520751953
Epoch 16 (12.9s): Lower bound = -99.3624267578125
Epoch 17 (12.8s): Lower bound = -99.09620666503906
Epoch 18 (12.9s): Lower bound = -98.78494262695312
Epoch 19 (13.0s): Lower bound = -98.54756164550781
Epoch 20 (13.2s): Lower bound = -98.28917694091797
>>> TEST (402.6s)
>> Test lower bound = -98.56088256835938
>> Test log likelihood (IS) = -93.06107330322266
```

3. Visualize the generations of your learned model. Set y observed as [1….K], and generate multiple x s for each y using your learned model. Include a few samples in your report.

I have compared with 2 images. I have found that after comparing 10 and 20 epochs. 20 was clearer on the edges and more readable.

Here are the comparison photos and the results:

10



20