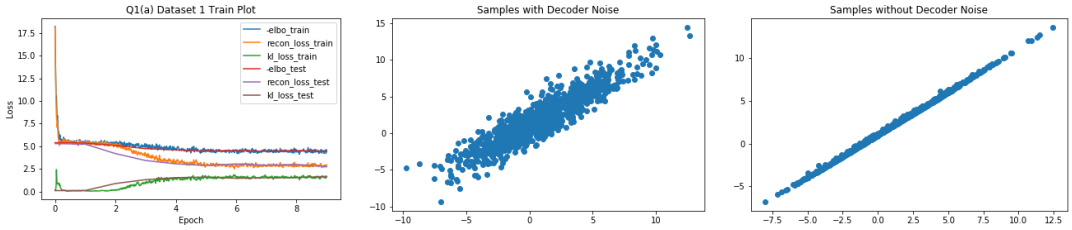
Homework 3: Latent Variable Models

Deliverable: This PDF write-up by **Tuesday March 10th, 23:59pm**. Your PDF should be generated by simply replacing the placeholder images of this LaTeX document with the appropriate solution images that will be generated automatically when solving each question. The solution images are automatically generated and saved using the accompanying IPython notebook. Your PDF is to be submitted into Gradescope. This PDF already contains a few solution images. These images will allow you to check your own solution to ensure correctness.

Question 1: VAEs on 2D Data [20pt]

(a) **[10pt] Data from a Full Covariance Gaussian**

Final Full -ELBO: 4.4388, Recon Loss: 2.7630, KL Loss: 1.6758 (Dataset 1)



(a) Training curve (b) Samples with Noise (c) Samples without Noise

Figure 1: Results for Dataset 1

Final Full -ELBO: FILL, Recon Loss: FILL, KL Loss: FILL (Dataset 2)

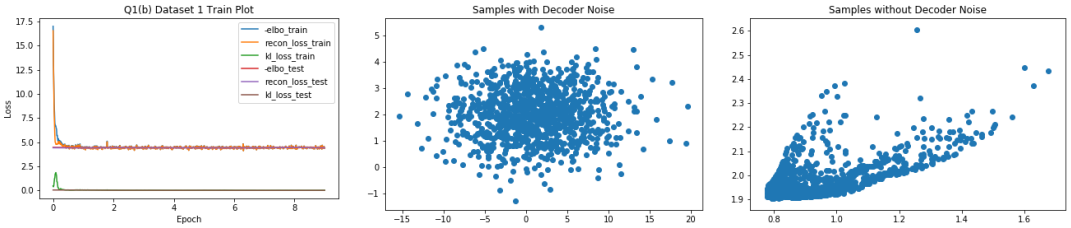
Placeholder Placeholder Placeholder

(a) Training curve (b) Samples with Noise (c) Samples without Noise

Figure 2: Results for Dataset 2

(b) **[10pt] Data from a Diagonal Gaussian**

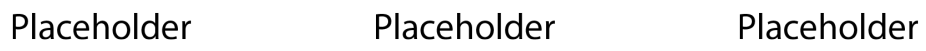
Final Full -ELBO: 4.4213, Recon Loss: 4.4094, KL Loss: 0.0119 (Dataset 1)



(a) Training curve (b) Samples with Noise (c) Samples without Noise

Figure 3: Results for Dataset 1

Final Full -ELBO: FILL, Recon Loss: FILL, KL Loss: FILL (Dataset 2)



(a) Training curve (b) Samples with Noise (c) Samples without Noise

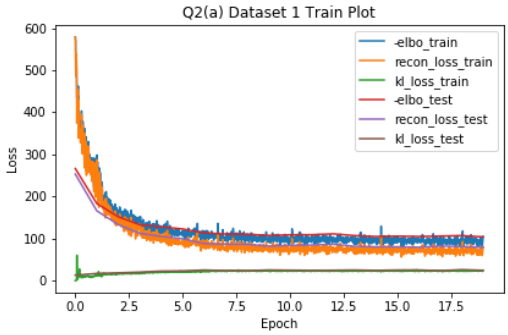
Figure 4: Results for Dataset 2

Answer: Your answer to the reflection portion of part (b) reflection here (replace this text)

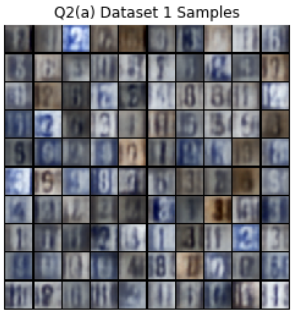
Question 2: VAEs on Images [40pt]

(a) **[20pt] VAE**

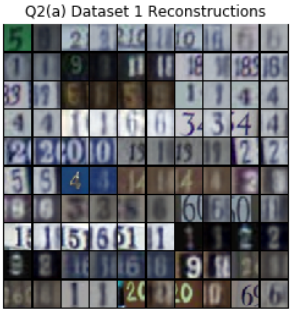
Final Full -ELBO: 104.0417, Recon Loss: 79.3798, KL Loss: 24.6620 (Dataset 1)



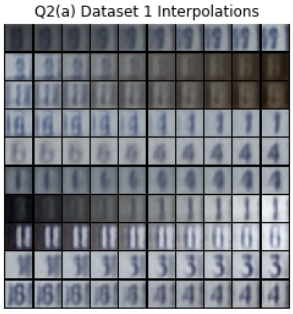
(a) Training Curve



(b) Samples



(c) Reconstructions



(d) Interpolations

Figure 5: Results for Dataset 1

Final Full -ELBO: FILL, Recon Loss: FILL, KL Loss: FILL (Dataset 2)

(a) Training Curve

(b) Samples

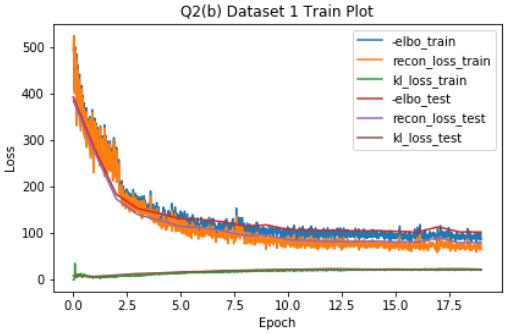
(c) Reconstructions

(d) Interpolations

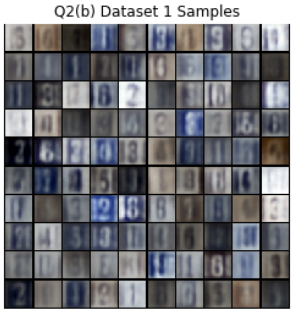
Figure 6: Results for Dataset 2

(b) **[20pt] VAE with AF Prior**

Final Full -ELBO: 102.5659, Recon Loss: 80.2548, KL Loss: 22.3111 (Dataset 1)

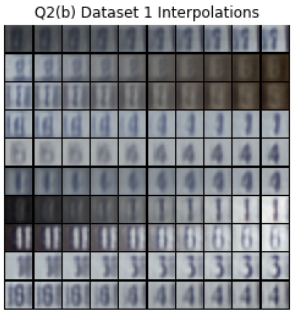


(a) Training Curve



(b) Samples

(c) Reconstructions



(d) Interpolations

Figure 7: Results for Dataset 1

Final Full -ELBO: FILL, Recon Loss: FILL, KL Loss: FILL (Dataset 2)

(a) Training Curve

(b) Samples

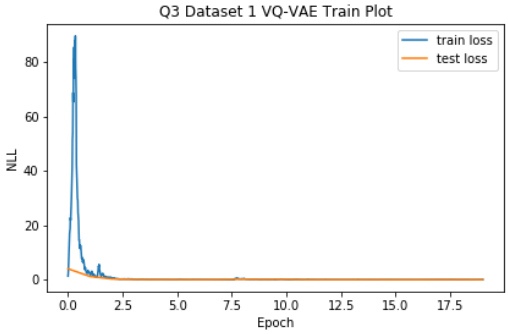
(c) Reconstructions

(d) Interpolations

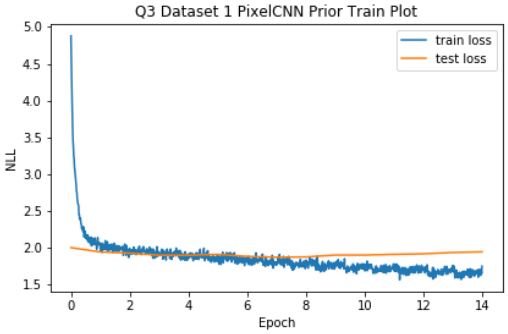
Figure 8: Results for Dataset 2

Question 3: VQ-VAE [40pt]

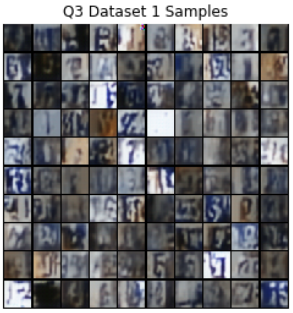
Final VQ-VAE Test Loss: 0.0286, PixelCNN Prior Test Los: 1.9440 (Dataset 1)



(a) VQ-VAE Training Curve



(b) PixelCNN Prior Training Curve



(c) Samples

(d) Reconstructions

Figure 9: Results for Dataset 1

Final VQ-VAE Test Loss: FILL, PixelCNN Prior Test Los: FILL (Dataset 2)

(a) VQ-VAE Training Curve

(b) PixelCNN Prior Training Curve

(c) Samples

(d) Reconstructions

Figure 10: Results for Dataset 1

Question 4: Bonus [10pt]

1. **[5pt] Improving VQ-VAE Results**

   Final VQ-VAE Test Loss: FILL, PixelCNN Prior Test Los: FILL

(a) VQ-VAE Training Curve

(b) PixelCNN Prior Training Curve

(c) Samples

(d) Reconstructions

Figure 11: Results for CIFAR10

2. **[5pt] PixelVAE**

   Final Full -ELBO: FILL, Recon Loss: FILL, KL Loss: FILL

(a) Training curve

(b) Samples

(c) Reconstructions

Figure 12: Results for MNIST