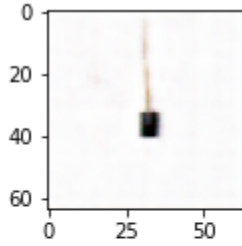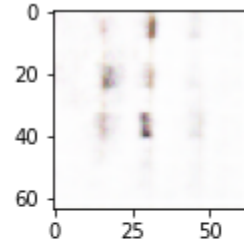**CMPE260 Spring23 Homework-1**

1. In this first part, the **model behaves as an autoencoder.** During the forward pass, the input image (X) is mapped to a point (Z) in the latent space by the encoder, and then Z is reconstructed to X̂ by the decoder. During sampling, a new data point is sampled in the latent space, and it is passed through the decoder.


2. In this part, the **model is upgraded to VAE.** In AEs, the input image is mapped to a point in the latent space, whereas in VAEs, the input image is mapped to a multivariate normal distribution in the latent space.
   The reparameterization trick is used in VAEs to enable efficient sampling from the learned latent space during training, and to allow the model to learn a smooth and continuous distribution over the latent space that can be used for generating new data points. For this purpose, z is created, and multiplied by randomness, as shown below.

$$z(x) = \mu_\theta(x) + \sigma_\theta(x).\varepsilon \tag{1}$$

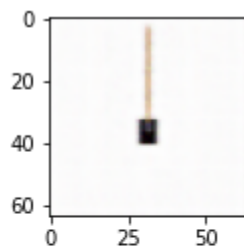where μ and σ are the average and standard deviation of the learned distribution respectively, and ε ~ **N(0, I).**
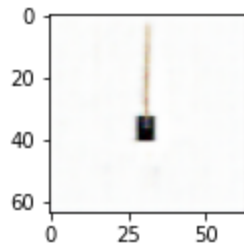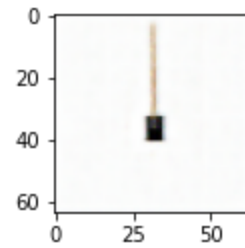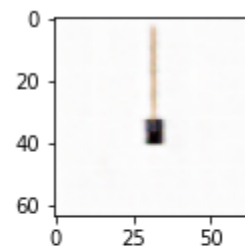
3. The Cartpole environment returns done=True if one of the following occurs:
    a. Termination: Pole Angle is greater than ±12° (i.e. obs[2] not in range(-0.2095, 0.2095))
    b. Termination: Cart Position is greater than ±2.4 (i.e. obs[0] not in range (-2.4, 2.4))
    c. Truncation: Episode length is greater than 500 (i.e. the agent successfully balances the pole for 500 time steps)

    In this part, **we reset the environment after the first 20 observations** from each episode.
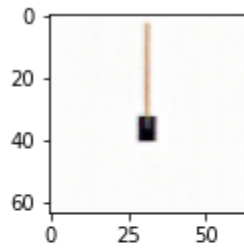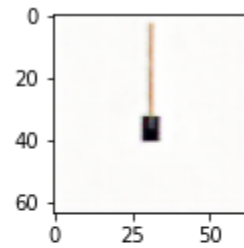
4. In this part, I modified the train_vae.py code such that the VAE will be trained with images in which the **pole angle is in the range (-0.025 rad, 0.025 rad) = (-1.4°, + 1.4°)**
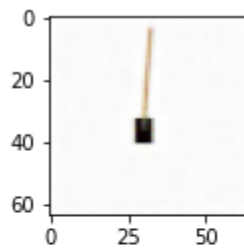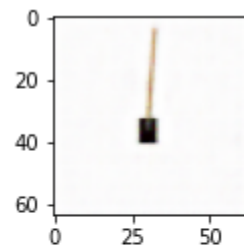

Generate

Generate

Additionally, when I limit the pole angle to be in the range (0.150 rad, 0.200 rad) = (8.6°, 11.5°), I got the below results, which are more obviously different from previous results.
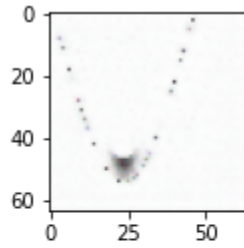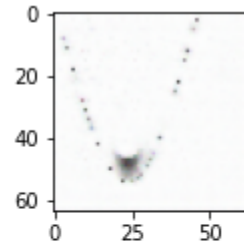

Generate

Generate

5. In this part, I trained the VAE with **images from the [mountain car](#) environment.** Two of the generated images are shown below.

Generate

Generate