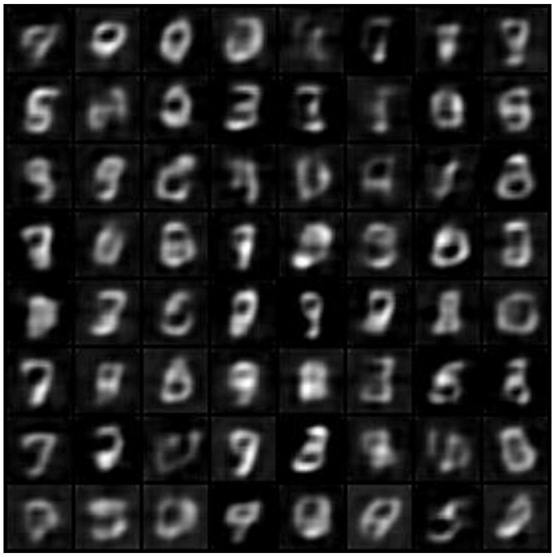
❖ VAE: After having trained the model, we ask you to provide the following additional results from your experiments. Please provide:

1. Some reconstructions from the test set and samples from the VAE model at the end of training:

Original Dataset:

Epoch 1:



Epoch 10:

Epoch 20:

Epoch 25:

Reconstruct:

2.How do the samples look? Do you see digit patterns ; are the samples blurry ?

The outcomes achieved with the VAE model demonstrate satisfactory quality, clearly presenting the numerical patterns. However, images generated by vanilla VAEs tend to be blurry. This blurriness stems from the VAE's loss function, which compromises between precise reconstruction and regularization. Encoding into a lower-dimensional space in VAEs can result in lost details, and the regularization process tends to produce smoother, more generalized images, further causing the blurriness.

2. Images of the Interpolation results from the code. Is the interpolation between two points smooth ? Do you see the images changing smoothly?

Yes, interpolation between two points typically results in smooth transitions in the generated images, with each image gradually and coherently changing from one to the next without abrupt shifts.

2.After having trained the model, we ask you to provide the following additional results and insights from your experiments. Please provide

1. Some generated samples from the GAN model at the end of training:

   Original Dataset:

Epoch 1:

Epoch 10:

Epoch 20:

Epoch 25:

2. How do the samples look ? Are they blurry ? Compare them with VAE samples.

The outcomes achieved with the GAN model demonstrate satisfactory quality, clearly presenting the numerical patterns. GAN generated samples are typically sharper and more detailed compared to VAE-generated images, which often appear blurrier due to their loss function and regularization techniques. GANs are generally superior in producing high-quality, realistic images.

3. Provide images for the interpolation result between two points from the noise distribution. Is the interpolation smooth?

interpolating between two points in the noise distribution typically results in smooth transitions in the generated images, with each image gradually changing in a coherent manner. However, the smoothness and predictability of these transitions can vary depending on how well the GAN is trained (Like number of Epoch).

4. In the training loop (second last cell), we needed to use .detach() in the discriminator training for the fake generated images. Is it essential, and if so, why?
   Yes, using .detach() is essential in the discriminator training of a GAN to prevent backpropagation through the generator. It ensures that only the discriminator's weights are updated during its training phase, maintaining separate and efficient training for both the discriminator and generator.
5. Can the GAN model, as it currently is, be used for (a) reconstructing input images, (b) computing (exactly or approximately) the log-likelihood, or (c) representation learning?

   A typical GAN is not the best fit for (a) accurately reconstructing input images, (b) calculating the log-likelihood of data, or (c) direct representation learning. Although GANs are proficient at creating new, convincing images, they are not equipped for exact input replication or straightforward log-likelihood calculations. Additionally, while GANs can facilitate representation learning, their effectiveness is outmatched by other models tailored specifically for this function

3. After having trained the model, we ask you to provide the following additional results and insights from your experiments. Please provide

1. Some generated samples from the Diffusion model at the end of training:

Original Dataset:

Epoch 1:

Epoch 10:

Epoch 20:

Epoch 25:

2.How do the samples look ? Compare them with VAE and GAN samples.

VAEs generate blurrier, less detailed images but offer stable training; GANs produce sharper, more realistic images but can face training challenges; Diffusion models excel in creating high-quality, highly realistic images, surpassing GANs in detail and texture, but require more time and computational resources.

4. What are the biggest strengths and draw-backs (in terms of quality and diversity of the generated samples, computational load at training and inference, etc)

a. VAE: VAEs are known for their stable training and effective data reconstruction capabilities, making them suitable for tasks requiring a good understanding of the overall data structure. They maintain a good diversity in generated samples but tend to produce images that are less sharp and detailed. The computational load for VAEs is moderate, offering a balance between efficiency and resource usage.

b. GAN: GANs, on the other hand, excel in generating high-resolution, realistic images, and have a wide range of variations due to extensive research in the field. However, they face challenges in training stability, often grappling with issues like mode collapse. GANs also might struggle with maintaining diversity in their outputs and are known for their high computational demands, especially for complex and high-resolution tasks.

c. DDMP: DDPMs stand out for their exceptional image quality, producing high-fidelity, detailed images. They offer great flexibility in generation tasks and maintain diversity well. However, their primary drawbacks include slower generation times due to the iterative process and significant computational resources needed, particularly during inference. This makes them less suitable for scenarios where quick generation or resource efficiency is critical. Each model, therefore, has a niche where it excels, with the choice depending on the specific requirements of the task at hand.