Abstract:

The aim of this study is to develop an autoencoder model that can reconstruct images from a combined dataset of MNIST and CIFAR-10 images. The model is built using PyTorch. The mean image is computed from random samples of MNIST and CIFAR-10, resized and channel-extended as necessary, and used to train the autoencoder. The performance is evaluated using visual inspection and quantitative metrics such as SSIM and PSNR.

Dataset Description:

The study uses the MNIST and CIFAR-10 datasets. MNIST consists of grayscale images (1 channel) of size 28x28 pixels, while CIFAR-10 consists of RGB images (3 channels) of size 32x32 pixels. For the purpose of this study, MNIST images are resized and channel-extended to match the dimensions and channels of CIFAR-10 images.

Introduction:

Image reconstruction models can benefit from combining diverse datasets. This study explores an autoencoder's ability to reconstruct images when trained on a mean image created from the MNIST and CIFAR-10 datasets. By leveraging the strengths of both datasets, the goal is to enhance the understanding of image representations and improve reconstruction quality.

Methods:

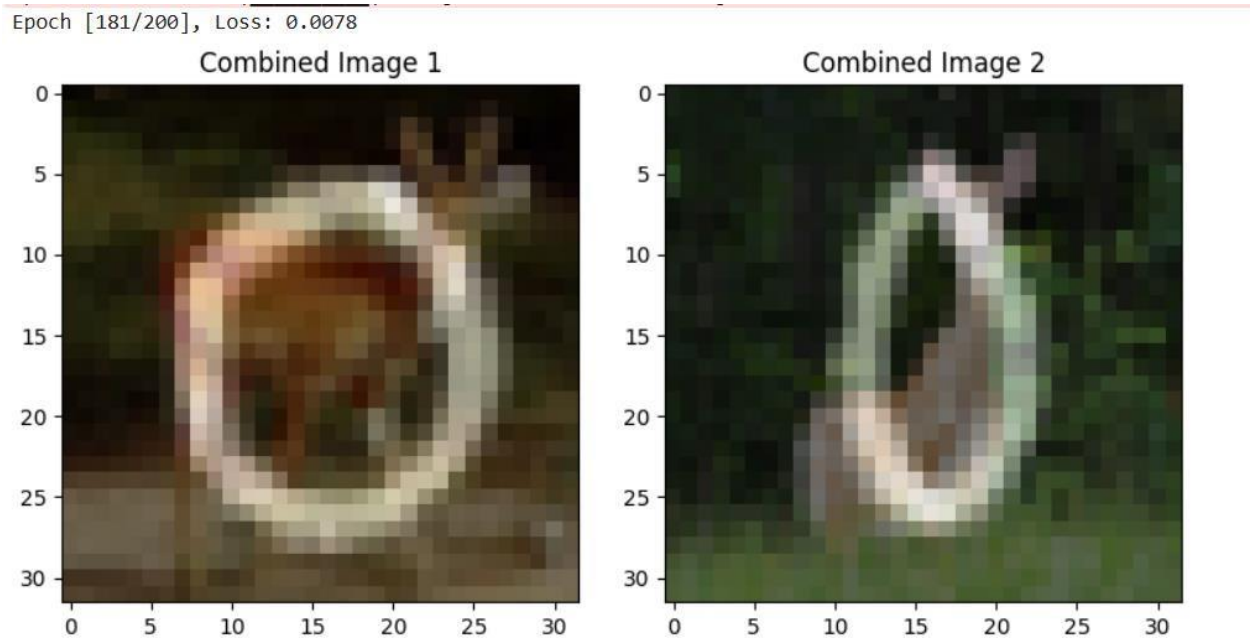
1. **Dataset Preparation:**
    - MNIST and CIFAR-10 datasets are loaded.
    - MNIST images are resized to 32x32 pixels and extended to 3 channels.
2. **Mean Image Computation:**

- One random image from MNIST and CIFAR-10 each is selected.
- The mean image is computed element-wise.

3. **Autoencoder Model Construction:**
   - An autoencoder is designed in PyTorch with an encoder to compress the input image into a latent representation and a decoder to reconstruct the image from this representation.
4. **Model Training:**
   - The mean image is used as input for training.
   - The Mean Squared Error (MSE) loss function is employed.
   - The Adam optimizer is utilized to update the model parameters.

Results:

The autoencoder was trained for 200 epochs using the computed mean image. Visual inspection of the reconstructed images indicates that the model successfully captures the structure of both MNIST and CIFAR-10 images. Quantitative evaluation using SSIM and PSNR further validates the reconstruction quality.



Evaluation:

- **Visual Assessment:** Reconstructed images were visually compared with original images. The autoencoder demonstrated satisfactory performance in reconstructing both MNIST and CIFAR-10 images from the mean image.
- **Quantitative Metrics:**
    - **SSIM (Structural Similarity Index):** Measures the similarity between the original and reconstructed images.
    - **PSNR (Peak Signal-to-Noise Ratio):** Evaluates the quality of reconstruction.

Conclusion:

The study successfully demonstrates the capability of an autoencoder trained on a combined mean image to reconstruct MNIST and CIFAR-10 images. The model shows promising performance, suggesting that combining diverse datasets can enhance image reconstruction tasks. Future work could explore more sophisticated network architectures and additional datasets to further improve reconstruction quality.