

Preliminary Exploration Using MNIST Dataset Highlights Autoencoders Limitations in Denoising Medical Images

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Questions this project attempts to answer:

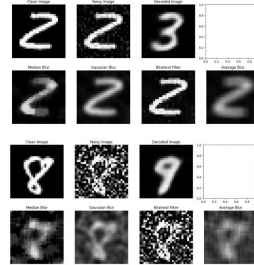
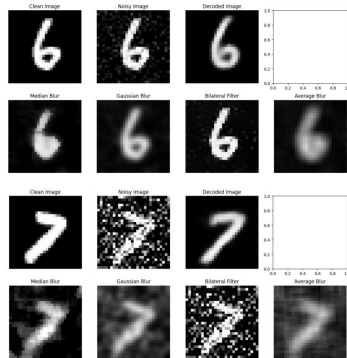
- Would autoencoders (AE) effectively denoise medical imaging?
- How do they compare to traditional methods qualitatively and quantitatively?
- Is the output quality consistent?

Methodology

- Simple grayscale images were used to evaluate the AE's denoising capabilities.
- Gaussian or Poisson noise was added to the images.
- The resulting image outputs and PSNRs were compared to traditional denoising methods.

Results and Conclusions

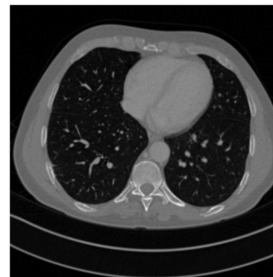
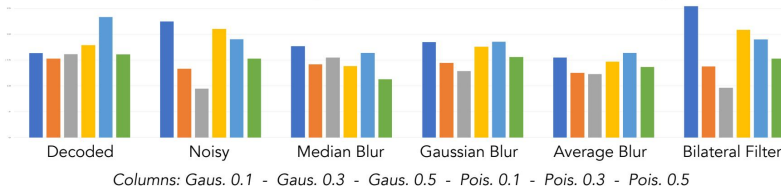
- The AE outperforms other techniques qualitatively, especially with higher noise levels, but exhibits some shape discrepancies.
- Quantitatively, it slightly surpasses other techniques, particularly with Gaussian noise.



PSNR is not always a reliable metric for the AE evaluation as it can lead to high scores even when the AE makes a reconstruction error / misclassification due to the latent space limitations.

- An autoencoder is not a good choice for denoising medical images due to shape discrepancies in the reconstructed images and limitations in the capacity of the latent space.
- AE shines at higher noise levels, but the noise level of quarter-dose CT scans are relatively low (left: full dose, right: quarter dose).
- In medical imaging, accurate representation of anatomical structures is crucial, and shape discrepancies can significantly affect the diagnostic value of the images.

PSNR of Different Denoising Methods for Different Noise Levels and Types



Literature Reviewed

J. M. Thomas and A. P. E. "Bio-medical Image Denoising using Autoencoders," 2022 Second International Conference on Next Generation Intelligent Systems (ICNGIS), Kottayam, India, 2022, pp. 1-6, doi: 10.1109/ICNGIS54955.2022.10079813.
 L. Gondara, "Medical Image Denoising Using Convolutional Denoising Autoencoders," 2016 IEEE 16th International Conference on Data Mining Workshops (ICDMW), Barcelona, Spain, 2016, pp. 241-246, doi: 10.1109/ICDMW.2016.0041.