IQIWA – Image quality improvement with autoencoders

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Introduction

- The focus of this project is to develop an efficient way of enhancing image quality for the purpose of medical diagnosis
- Our approach is based on convolutional neural networks that are best suited for image processing

Key contributions:

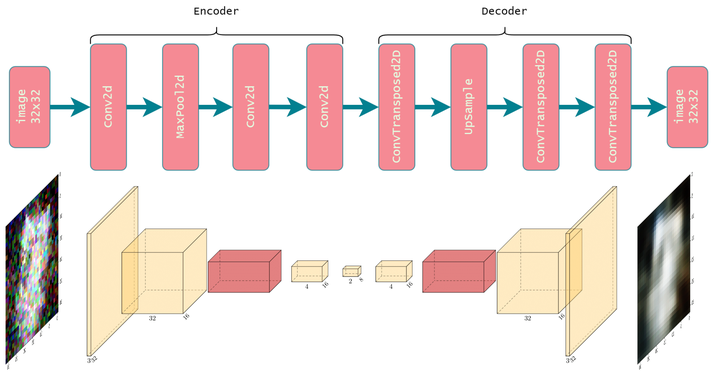
- **Convolutional** autoencoders for image denoising
- Deconvolutional network for image resolution enhancement
- Residual neural network for better image resolution enhancement
- **MSE, PSNR, SSIM losses, with introduced our own Loss function**
- Residual neural networks

Models

Image denoising

Convolutional autoencoder

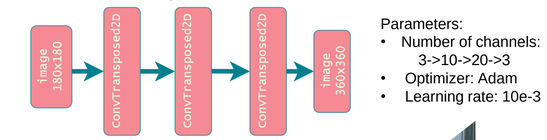
A convolutional autoencoder is a neural network that is trained to reproduce its input image in the output layer. An image is passed through an encoder, that produces a low-dimensional representation of the image. The decoder takes this compressed image and reconstructs the original image.



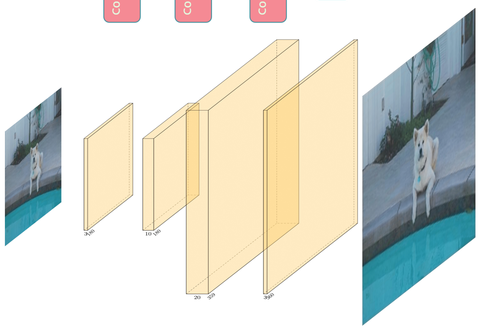
Resolution enhancement

Deconvolutional neural network

As we were using autoencoders in a previous case we decided to try to implement a simple decoder for image resolution enhancement.

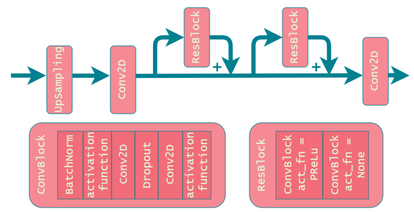


Parameters:
- Number of channels: 3->10->20->3
- Optimizer: Adam
- Learning rate: 10e-3



Residual neural network

More advanced residual neural network has better performance over the baseline model.



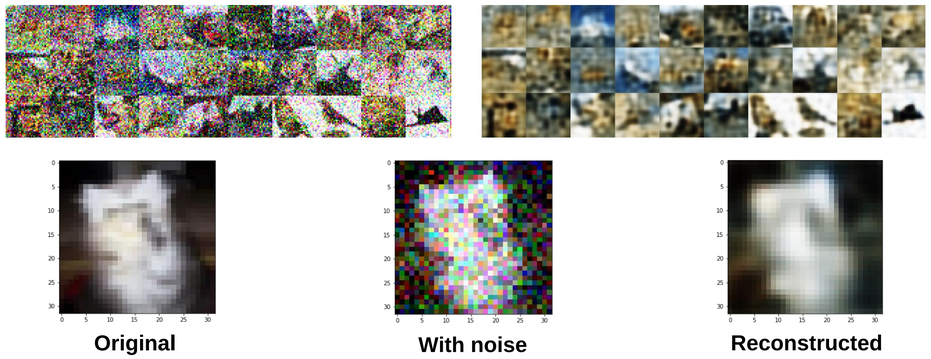
Parameters:
- Input image size: 90x90
- Dropout: 10%
- Number of channels in ResBlock: 64
- Optimizer: Adam
- Learning rate: 10e-3

Loss functions [4]:

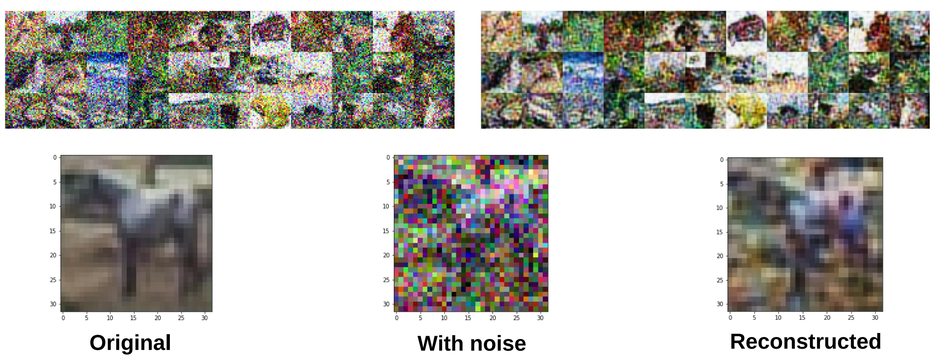
- $MSE = \frac{1}{n}\sum(\hat{Y} - Y)^2$
- $PSNR = 10 * \log_{10}\frac{MAX^2}{MSE}$
- $SSIM(x,y) = \frac{(2\mu_x\mu_y+c_1)(2\sigma_{xy}+c_2)}{(\mu_x^2+\mu_y^2+c_1)(\sigma_x^2+\sigma_y^2+c_2)}$
- $WPWLoss = MSE + L1PixelWise * 100$

Results

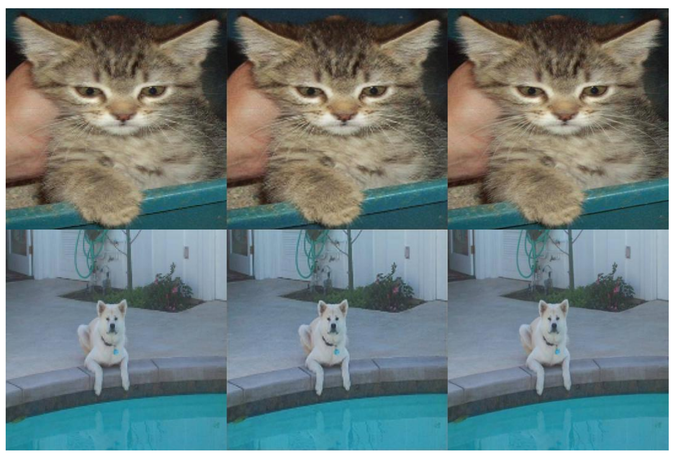
Autoencoder trained on images without noise



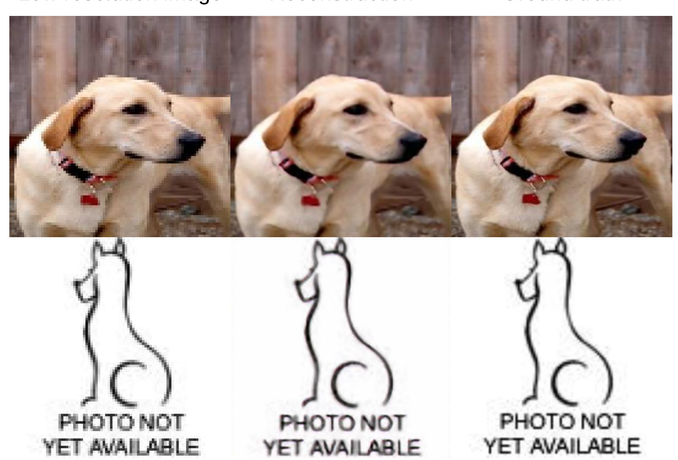
Autoencoder trained on images with noise



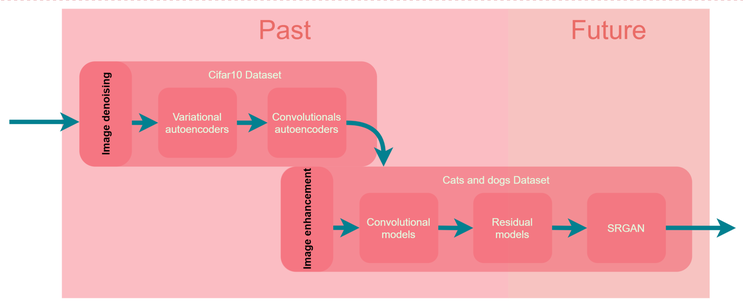
Deconvolutional neural network



Resnet



Future work



References

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[2] Deep Learning for Image Super-Resolution
https://www.analyticsvidhya.com/blog/2021/05/deep-learning-for-image-super-resolution/
[3] Christian Ledig Photo-Realistic Single Image Super-Resolution Using a Generative Adversarial Network
[4] https://towardsdatascience.com/deep-learning-image-enhancement-insights-on-loss-function-engineering-f57ccbb585d7