

Alma Mater Studiorum University of Bologna

Artificial Intelligence - Deep Learning
Deep Deblurring project

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Introduction

Problem

Remove blurring artifact from images

- ▶ CIFAR10[1]
- ▶ REDS[2]

Introduction

Hardware

- ▶ CPU: i7-8750H@2.20GHz
- ▶ GPU: Nvidia GTX 1060 (6 GB)

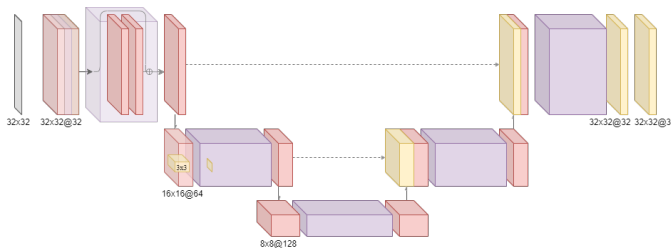
Autoencoders

Networks implemented:

- ▶ ResUNet
- ▶ EDDenseNet
- ▶ CAESSC
- ▶ SRNDeblur

Autoencoders - ResUNet[3][4]

Architecture



- ▶ The backbone is a UNet architecture
- ▶ Use of ResBlock at each level improves the flow of the information
- ▶ $\text{Conv} \rightarrow \text{BN} \rightarrow \text{ReLU}$
- ▶ Conv2DTranspose at the end for learning additional information

Autoencoders - ResUNet[3][4]

Results

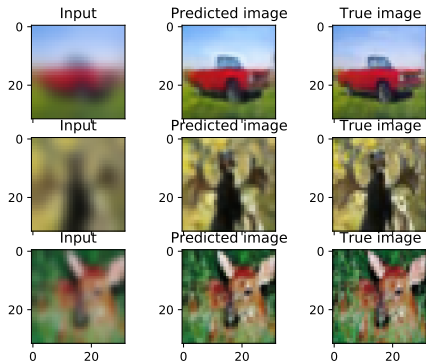


Figure: ResUNet1

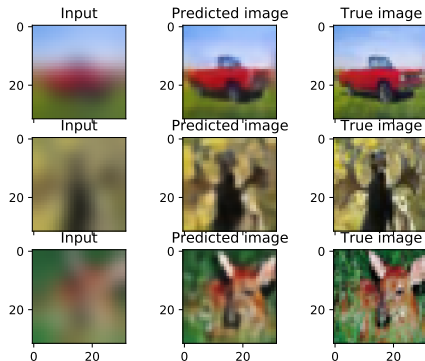
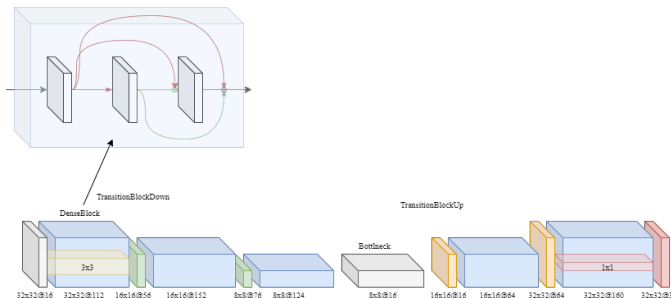


Figure: ResUNet3

Autoencoders - EDDenseNet[5]

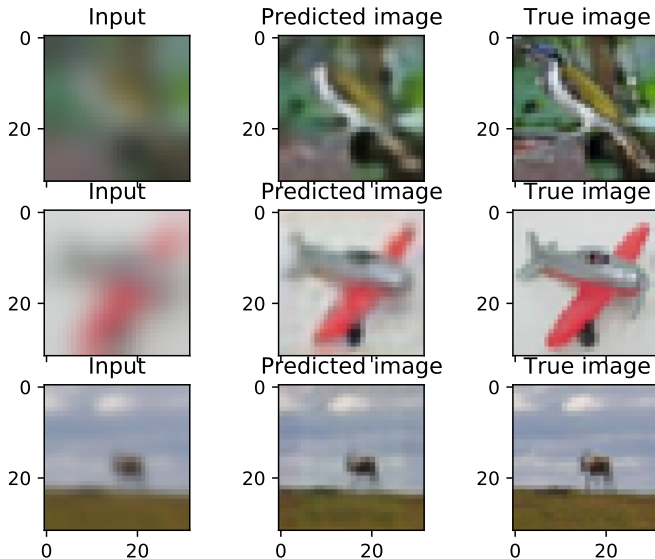
Architecture



- Encoder-Decoder architecture
- Use of DenseBlock
- $\text{Conv} \rightarrow \text{BN} \rightarrow \text{ReLU}$
- Conv2dTranspose at the end

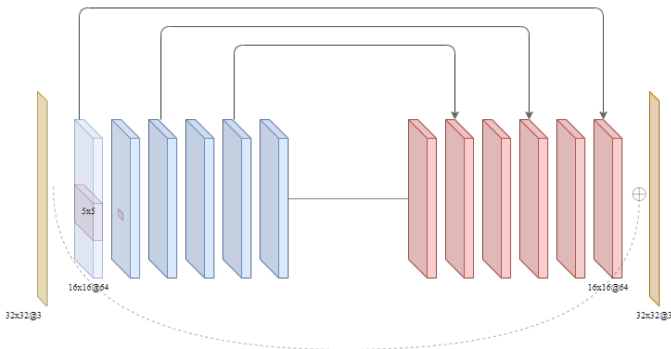
Autoencoders - EDDenseNet[5]

Results



Autoencoders - CAESSC[6]

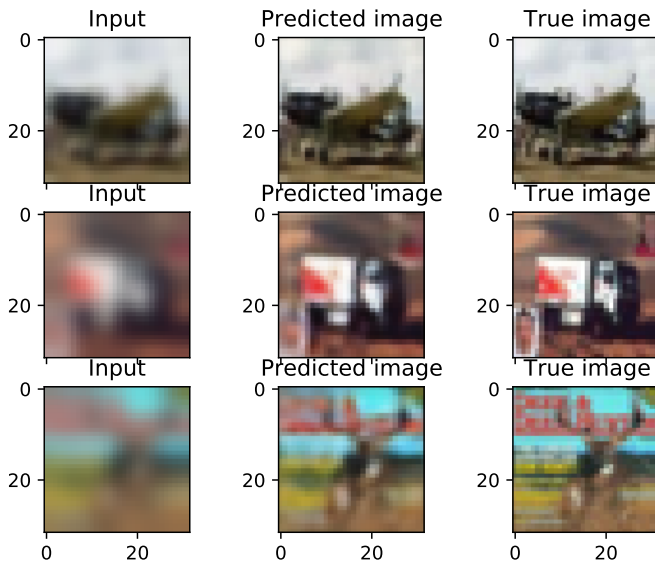
Architecture



- ▶ Simple structure
- ▶ Use of symmetric skip connections between with a fixed interval
- ▶ Use of highway skip connection improve the outcome

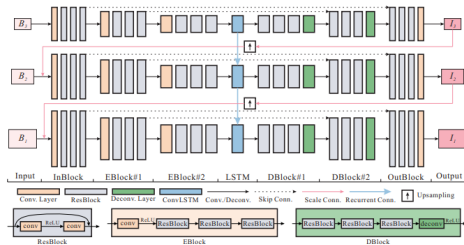
Autoencoders - CAESSC[6]

Results



Autoencoders - SRNDeblur[7]

Architecture

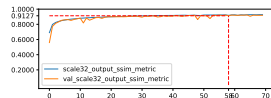
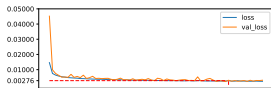


- ▶ FCNN
- ▶ Use of Blocks
- ▶ Encoder-Decoder architecture
- ▶ ResBlocks and skip connections
- ▶ Multi-Scale network
- ▶ Recurrent layer

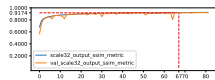
Autoencoders - SRNDeblur[7]

Training

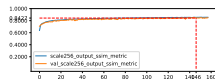
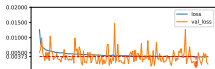
SRNDeblur_cifar_no_lstm



SRNDeblur_cifar_lstm



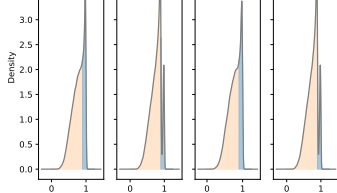
SRNDeblur_reds



KDE of the training set after 5 iterations

FULL ssim=1.0 FULL ssim=0.9 HALF ssim=1.0 HALF ssim=0.9

ssim	ssim	ssim	ssim
0.70656870	0.872951356	0.70903872	0.872951356
0.29343125	0.127048643	0.29096127	0.127048643



Autoencoders - SRNDeblur[7]

Results

Figure: Test image generated by SRNDeblur_cifar network

Autoencoders - SRNDeblur[7]

Results









Figure: High resolution test image generated by SRNDeblur_reds network.

Autoencoders - SRNDeblur[7]

Results



Figure: Low resolution test image generated by SRNDeblur_recs network.

-  A. Krizhevsky, “Learning multiple layers of features from tiny images,” 2009.
-  S. Nah, S. Baik, S. Hong, G. Moon, S. Son, R. Timofte, and K. M. Lee, “Ntire 2019 challenge on video deblurring and super-resolution: Dataset and study,” in *The IEEE Conference on Computer Vision and Pattern Recognition (CVPR) Workshops*, June 2019.
-  O. Ronneberger, P. Fischer, and T. Brox, “U-net: Convolutional networks for biomedical image segmentation,” *CoRR*, vol. abs/1505.04597, 2015.
-  K. He, X. Zhang, S. Ren, and J. Sun, “Deep residual learning for image recognition,” *CoRR*, vol. abs/1512.03385, 2015.
-  G. Huang, Z. Liu, and K. Q. Weinberger, “Densely connected convolutional networks,” *CoRR*, vol. abs/1608.06993, 2016.
-  X. Mao, C. Shen, and Y. Yang, “Image restoration using convolutional auto-encoders with symmetric skip connections,” *CoRR*, vol. abs/1606.08921, 2016.