

## 1. Data

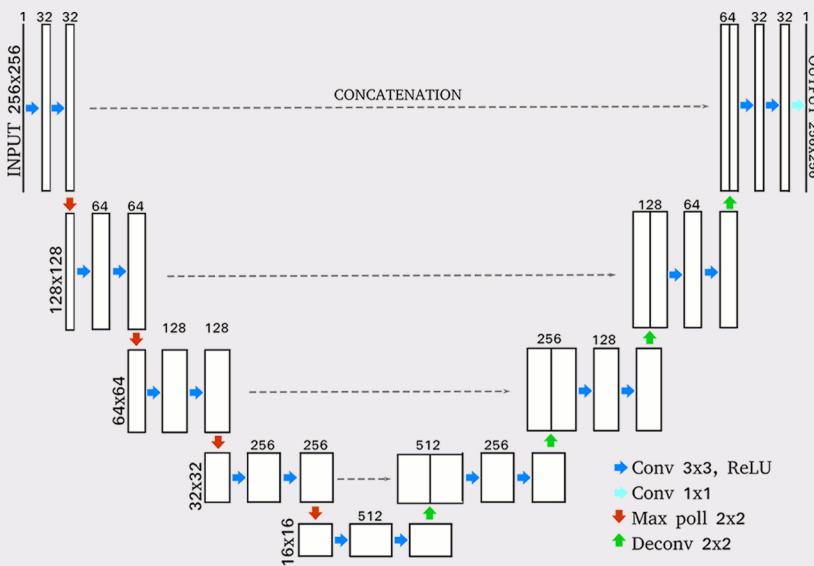
Dataset: Hubble Space Telescope (HST)  
WFC3/UVIS  
F555W, F606W

Images from HST → the ground truth

The input to the network → synthetic data,  
generated based on the real data but with  
additional noise and shorter exposure times

## 2. Method

U-net (Ronneberger et al. 2015) is a fully- convolutional network. To adapt the network on the data, the network needs to be trained.



F1. Architecture of the U-net. The different colored arrows represent operations between layers. The number above images denote the number of feature maps in the layer and the dashed line shows which layer is concatenated in the up-sample part of network.

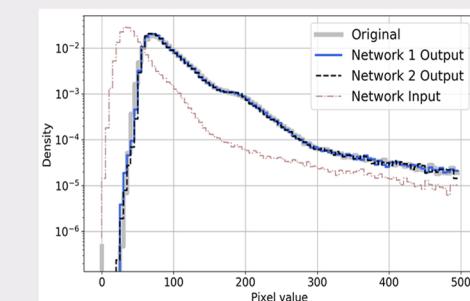
# Learning to Denoise Astronomical Images with U-nets

## 3. Results

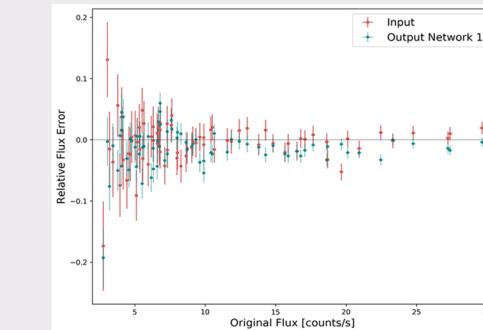
We trained more than 30 different networks with changes to hyper-parameters as: The loss function, The number of input/output channels, The activation function, etc... Used metrics: PSNR, SSIM, F-measure, SNR, Source detection, Relative Flux error, Kullback-Leibler divergence

The best performing networks:

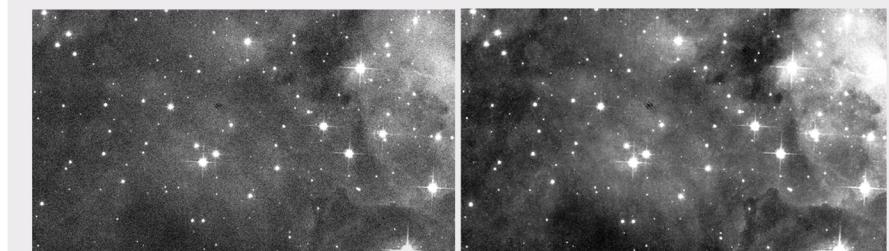
- . Increased of the Output SNR / Input SNR ~ 1.6 times
- . Mean Relative Flux Error~ 2.3%
- . F-measure ~ 0.8
- . True positive rate of detected stars ~ 96%



F2. Comparison of pixel distribution of the short exposure input image (pink), the long exposure ground truth (grey) and outputs of the network. The distribution of the output images fit the distribution of the ground truth.



F3: Star flux recovered by the network is in good fit with the flux of the ground truth with relative flux error (in percentage)  $1.45 \pm 0.13\%$  and lower uncertainty than on the input image ( $1.39 \pm 0.19\%$ ).



F4: Left: Short exposure time image, input to the network. Right: Image reconstructed by Network 1, the output image. The SNR for the output image is 1.5 times higher than the SNR of the input image.

## Contact

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github.com/Sponka/Astro\_U-net