Understanding Neural-Network Denoisers Through An Activation Function Perspective

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1. INTRODUCTION

Goal: Neural-network denoiser

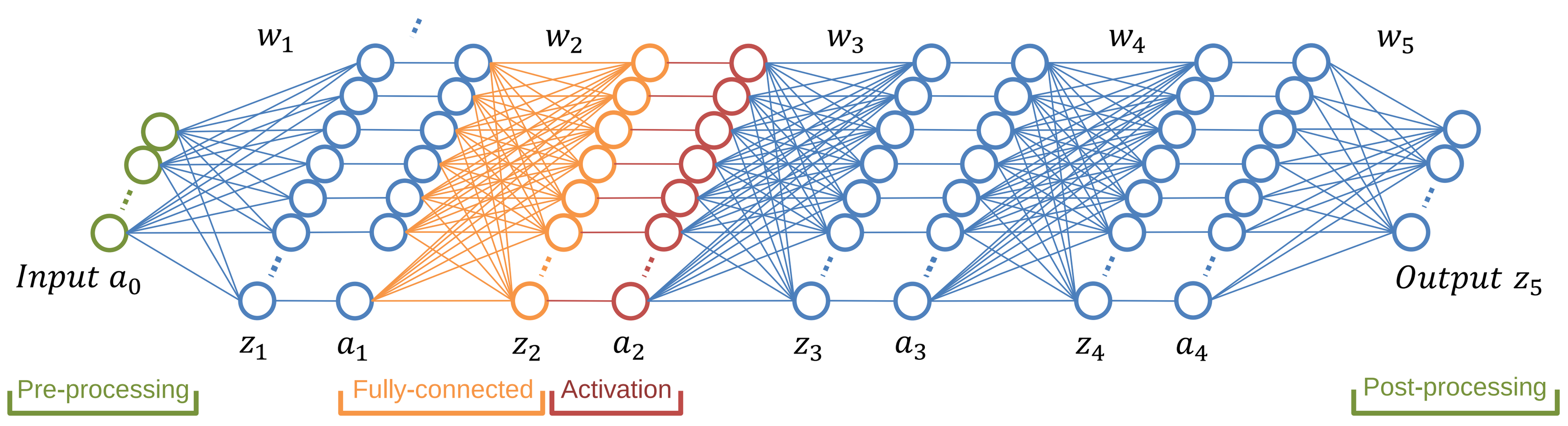
- Achieve state-of-the-art performance with neural network [1][2]
- Understand the denoising mechanism
- Relate neural network with traditional denoising methods

2. DENOISING PIPELINE

Datasets

- *Training set*: 50,000 images from ImageNet validation set 2010 [3]
- *Test set*: Barbara, Cameraman, Shepp-Logan phantom and 200 images from ImageNet test set 2010 [3]

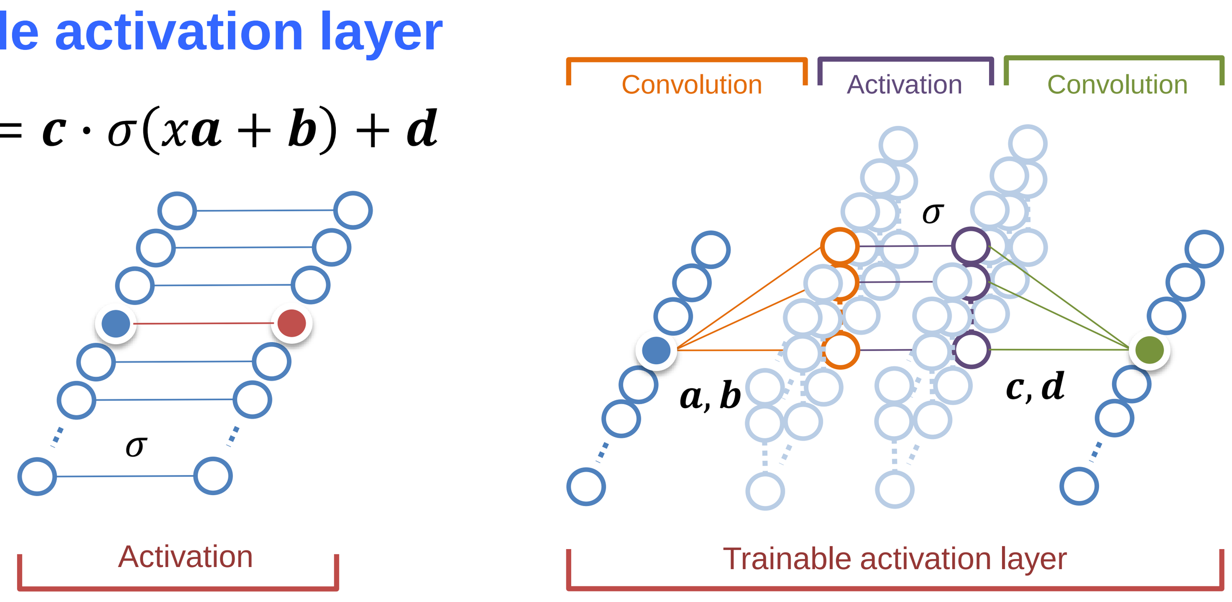
Neural network structure [2]



- Plain neural network
- 4 layers, 2047 neurons in each
- Input / output of size 17 * 17 (patch denoiser)

Trainable activation layer

- $f(x) = \boldsymbol{c} \cdot \sigma(x\boldsymbol{a} + \boldsymbol{b}) + \boldsymbol{d}$



3. RESULTS

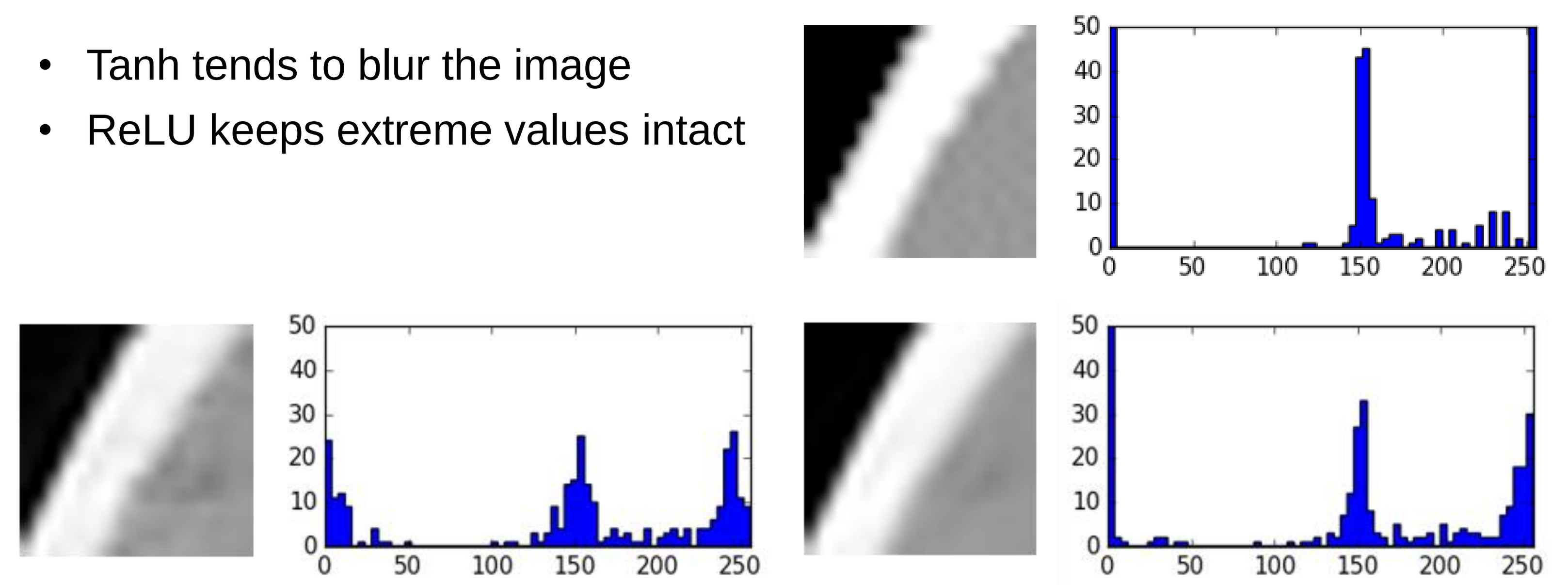
Compared with BM3D [1]

- PSNR on *test set*

Image	Barbara	Cam.man	Phantom	Avg.Other
Noisy	20.28	20.55	21.53	20.63
BM3D	**30.67**	29.11	29.55	28.61
tanh	28.11	28.97	31.87	29.11
ReLU [4]	29.33	**29.28**	32.80	**29.38**
Trained	29.16	29.22	**32.91**	29.28

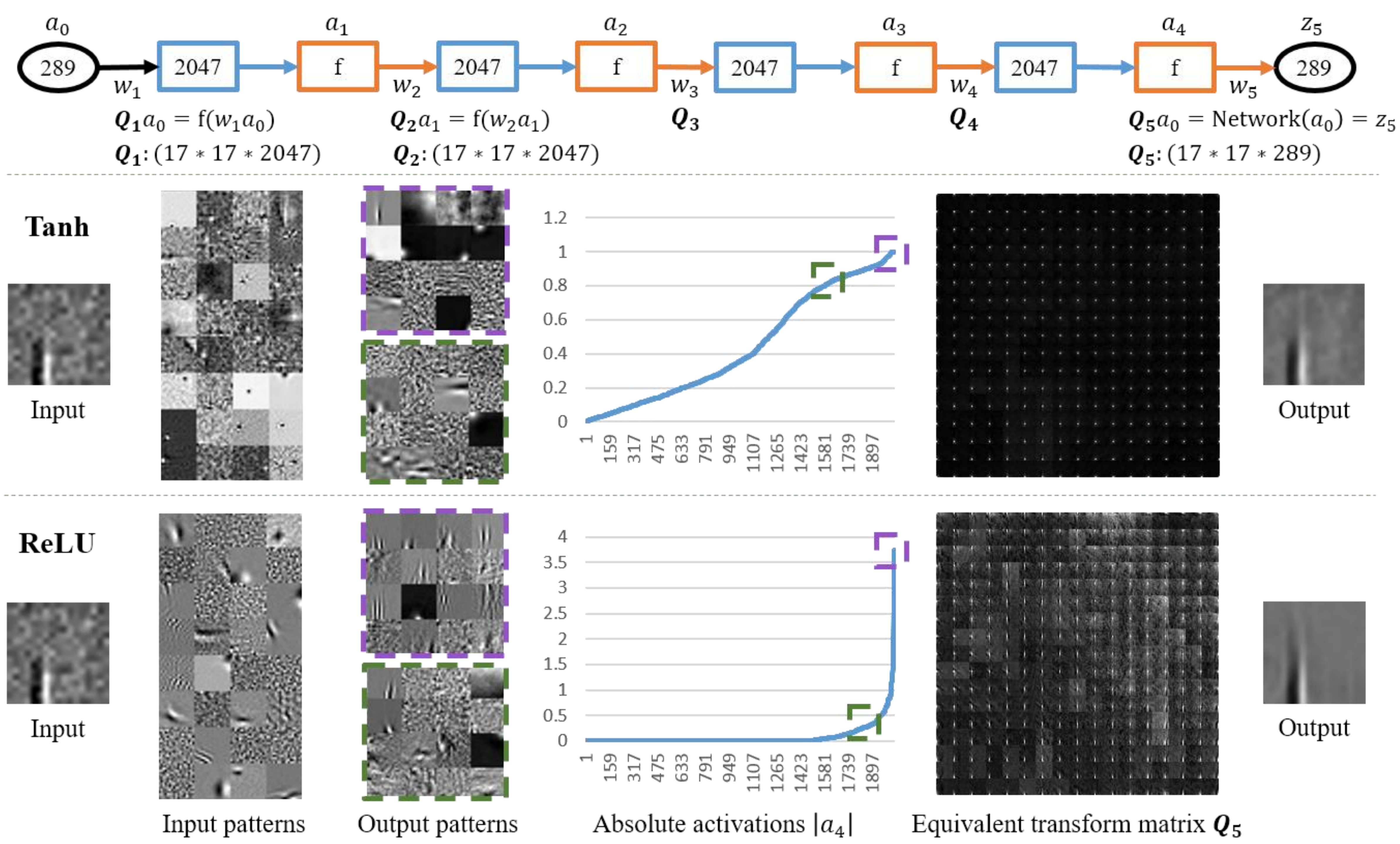
- Denoising results on Barbara (Noisy, tanh and ReLU [4])

- Denoising results on black and white patch (Phatom)
  - Tanh tends to blur the image
  - ReLU keeps extreme values intact

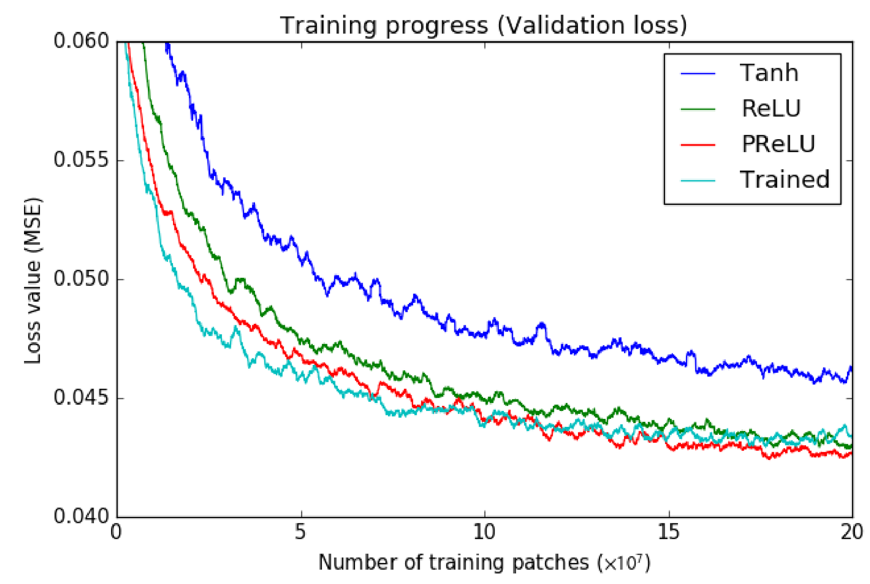


4. ANALYSIS

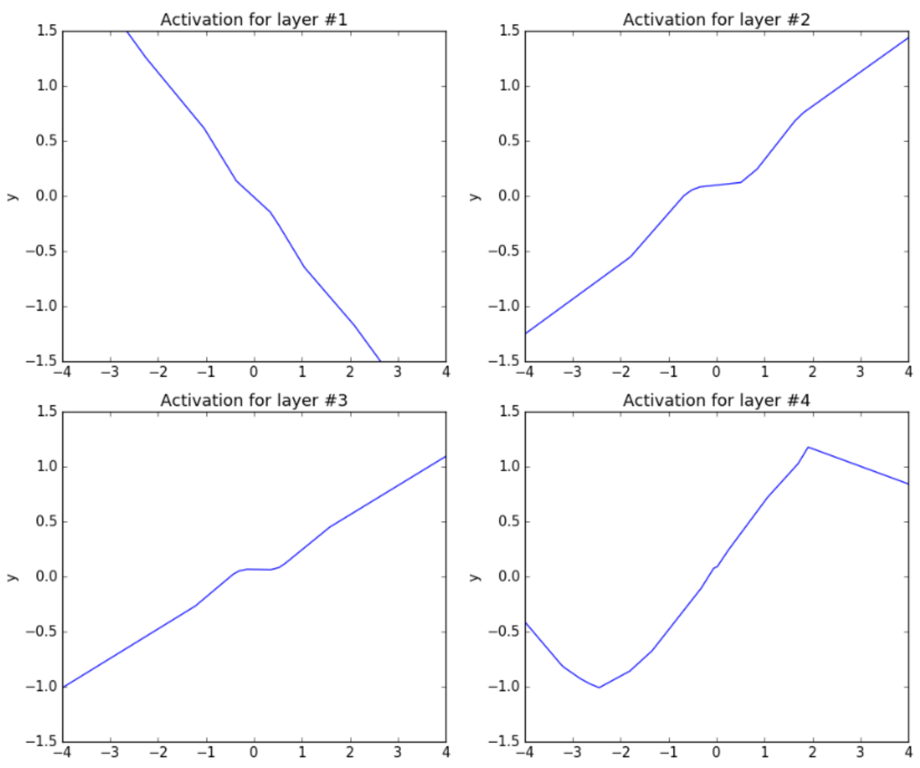
Feature maps and activation of neurons



Learning curve



Learned activation functions [5]



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