CNN demosaicking generalizes for any CFA

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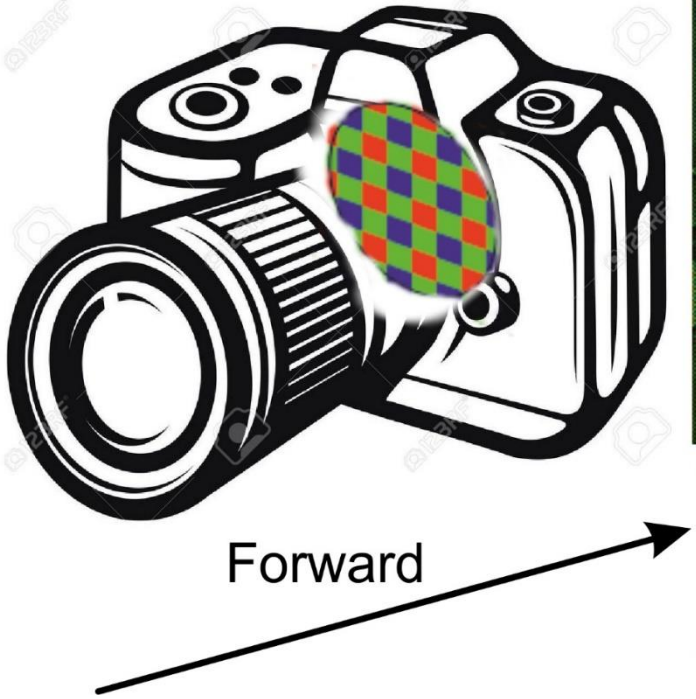
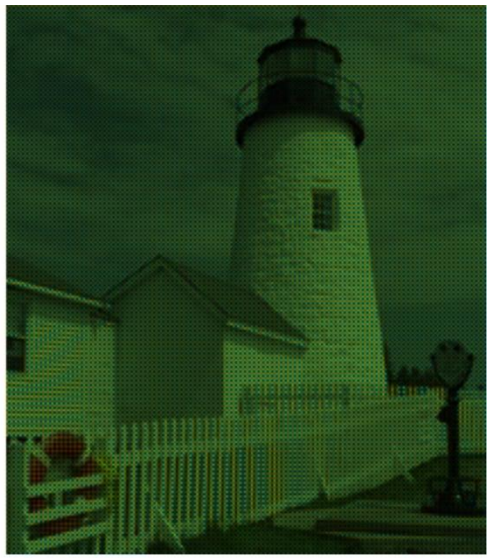
Context - Demosaicking

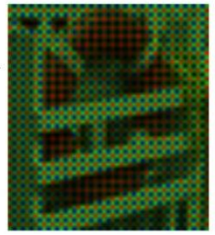
Acquiring image: single sensor imaging (mimetic with human vision)

RAW image

Original image

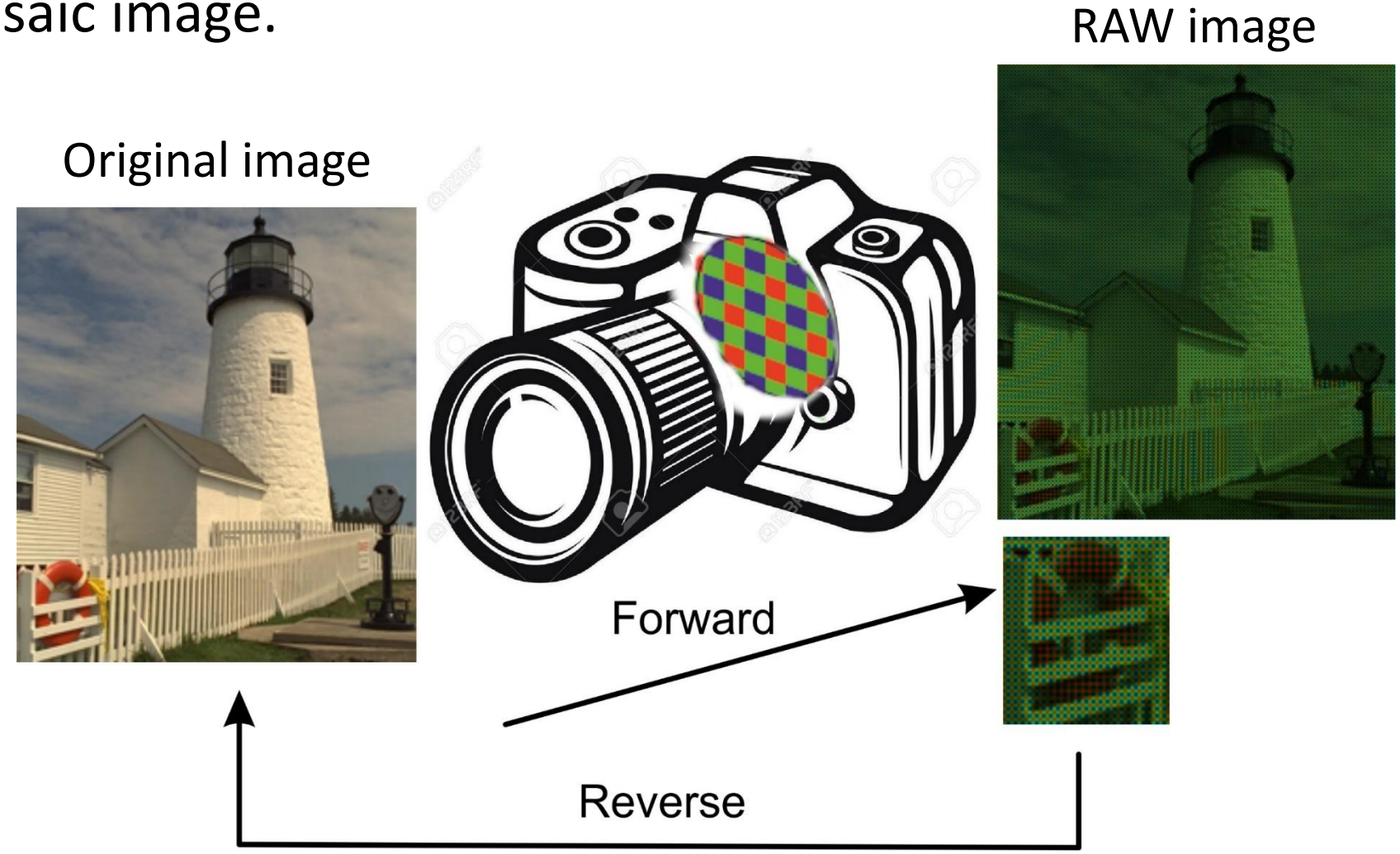






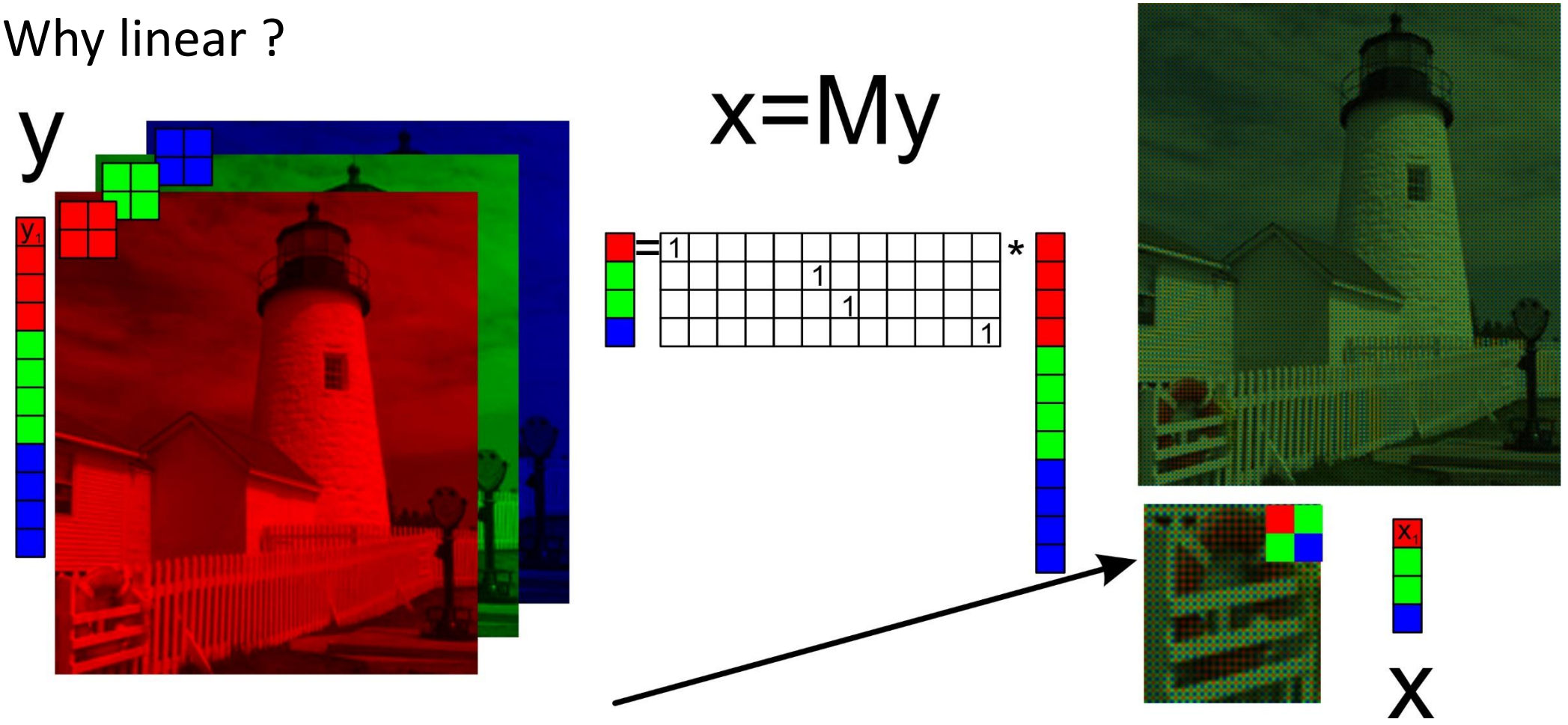
Context - AI

- Inverse system: finding the color image that the camera projects onto the mosaic image.



Solution 1: Linear demosaicking

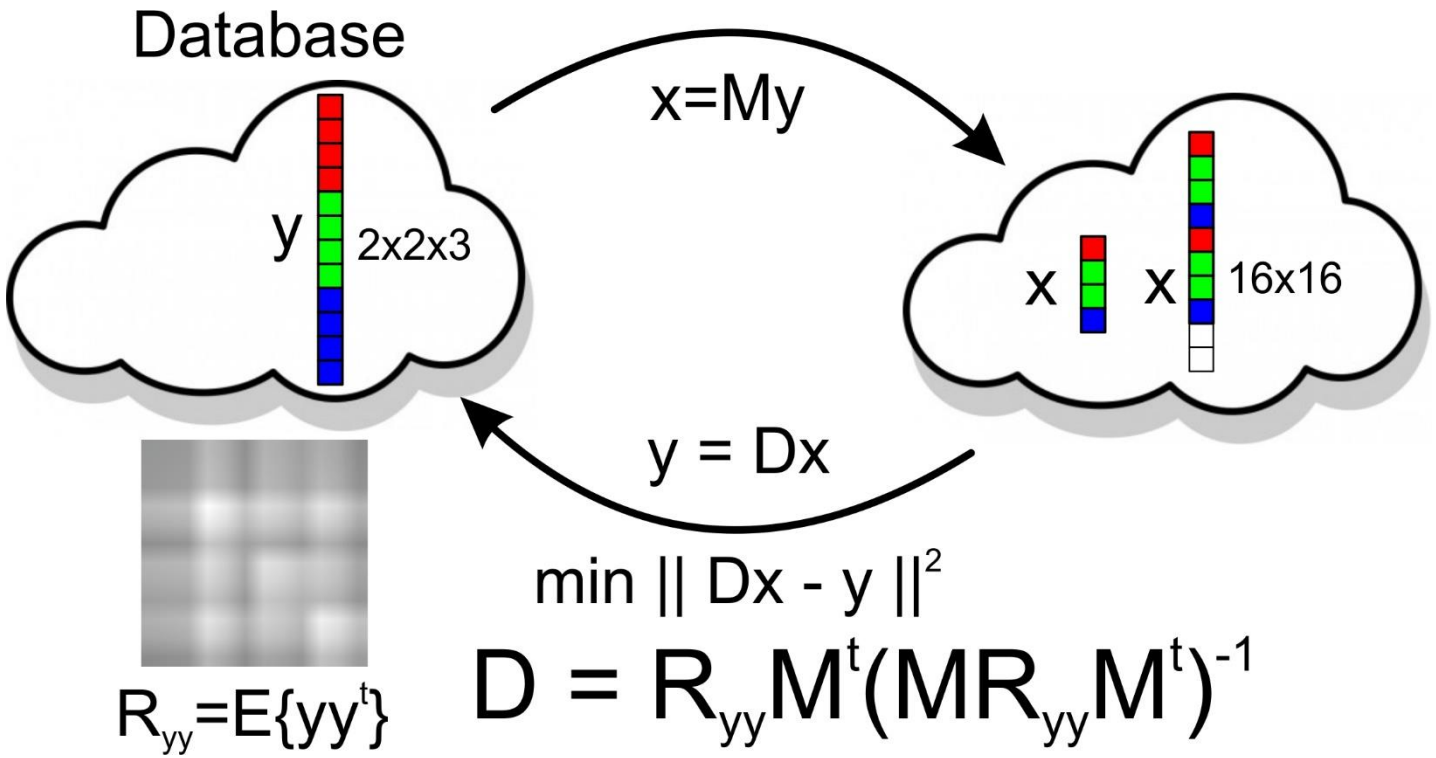
- Why linear ?



If the operator is linear and the estimator is the mean square error, then LMMSE (Linear Minimum Mean Square Error) estimation is a direct solution.

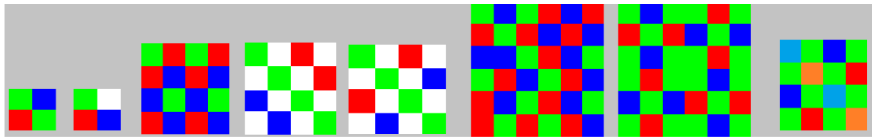
Solution 1: Linear demosaicking

- From a cloud of color images



Using neighborhood in RAW image for regularization

- One solution for a given database
- Few images to learn
- Low cost solution (to learn and test)
- Scalable solution nh * nw x hwp



- Works well for Hyperspectral imaging
- Can handle random mosaic by local processing

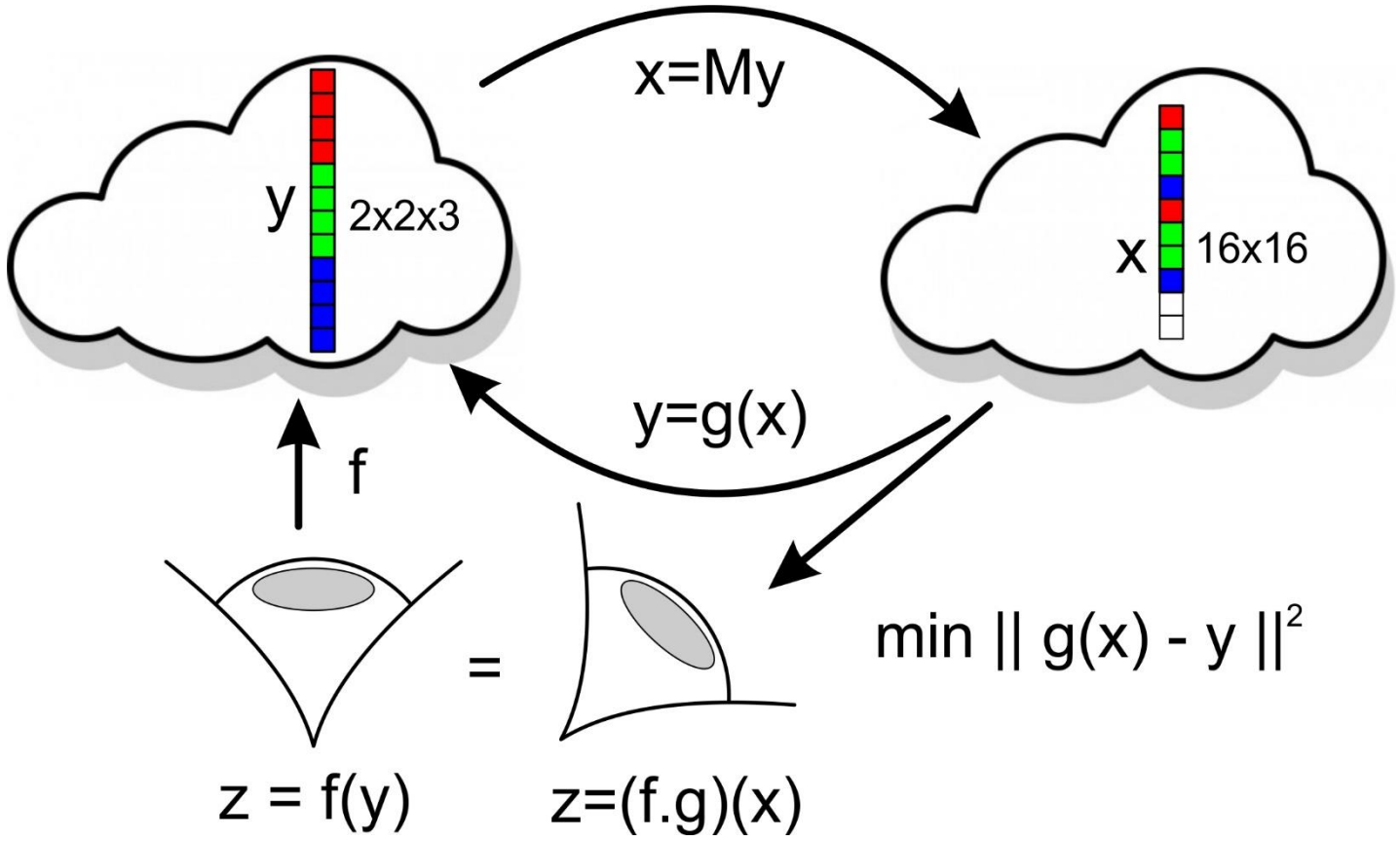
PSNR = 40 dB

for 4x4 #2 on Kodak

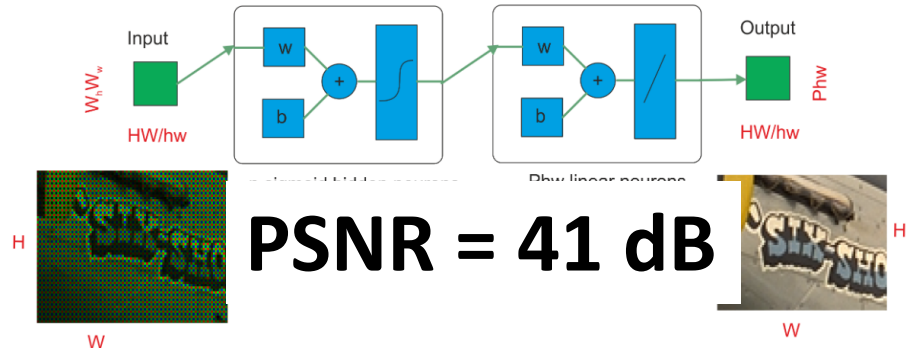
Amba & al., CIC 2016

Other solutions: Non-linear operators

- Many of them: ANN (Artificial NN), CNN (Convolutional NN) with MSE (Minimum Square Error).

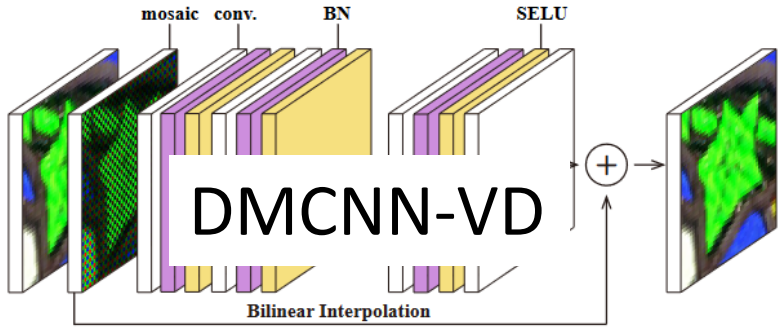


Amba et al. CIC 2018



PSNR = 41 dB

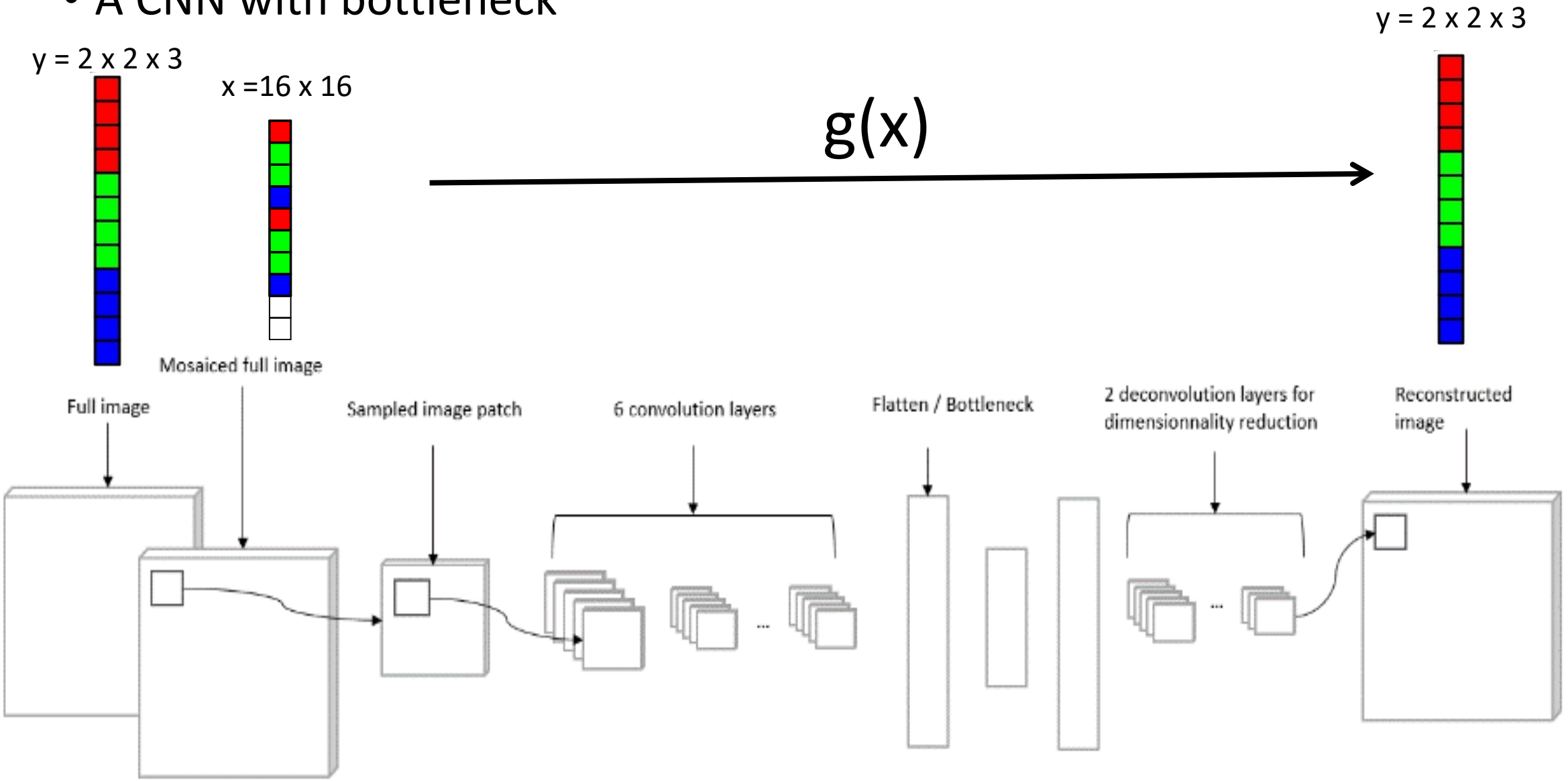
Syu et al. Arxiv 2018



PSNR = 43 dB

What we did

- A CNN with bottleneck

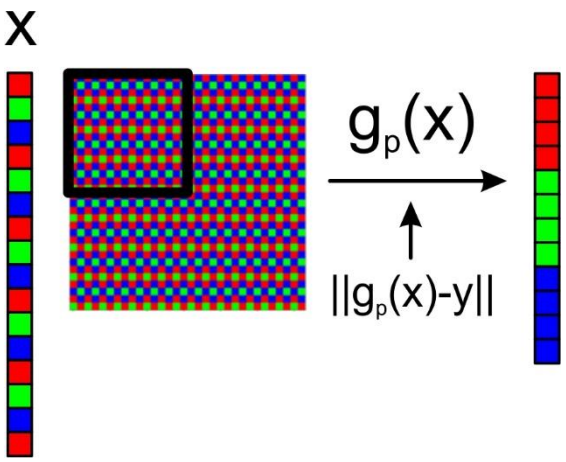


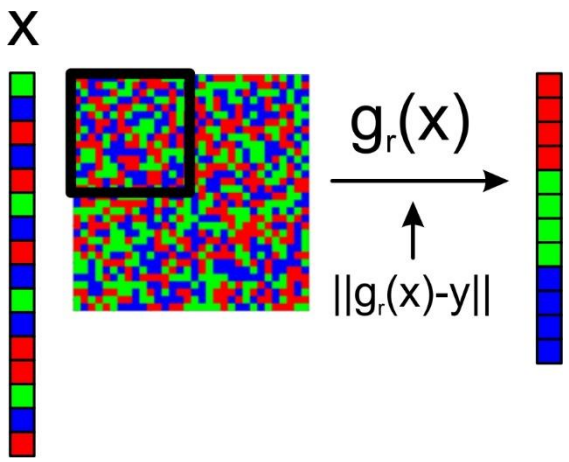
Experiment 1

Periodic CFA

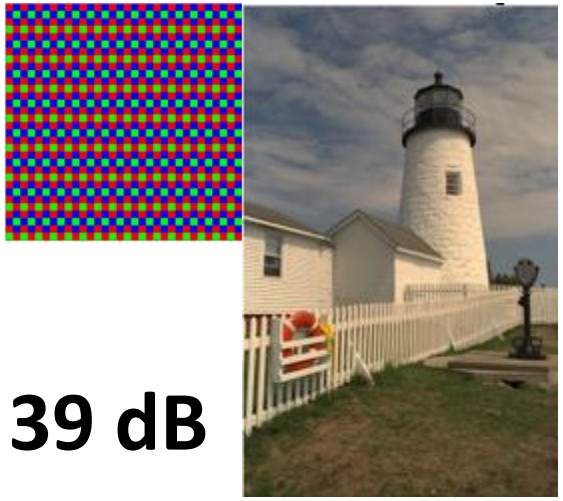
Random CFA

Train

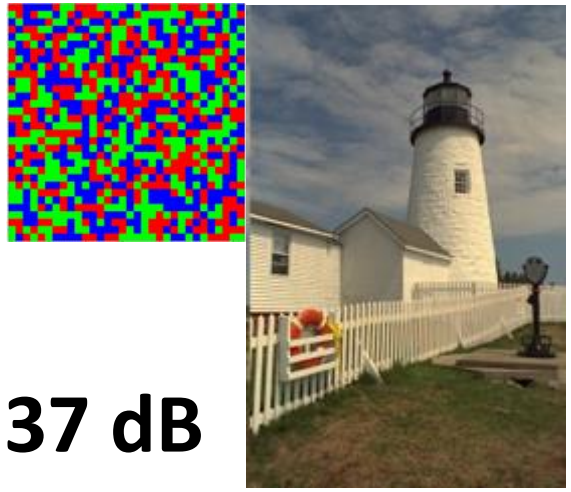




Test



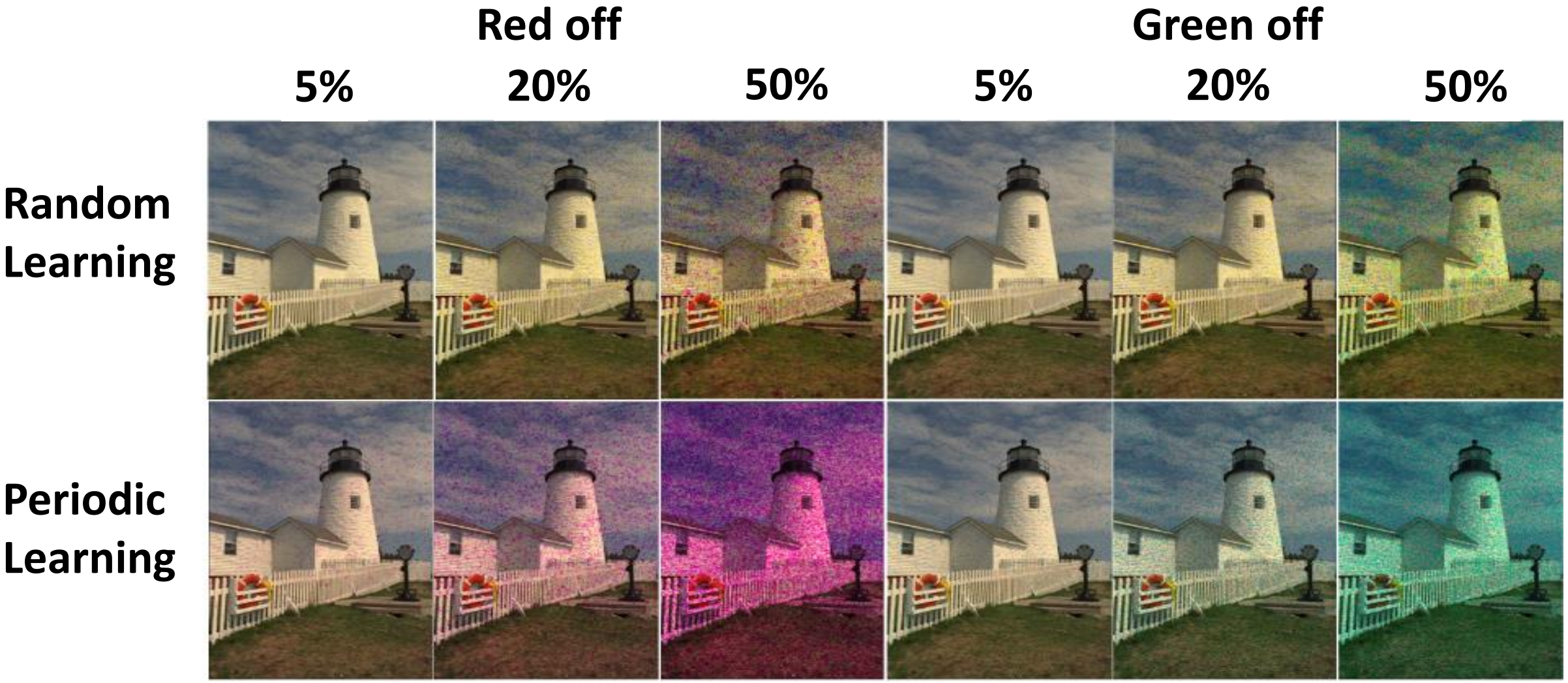
PSNR = 39 dB



PSNR = 37 dB

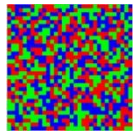
Is it working?

- Image degradation

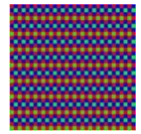


Experiment 2

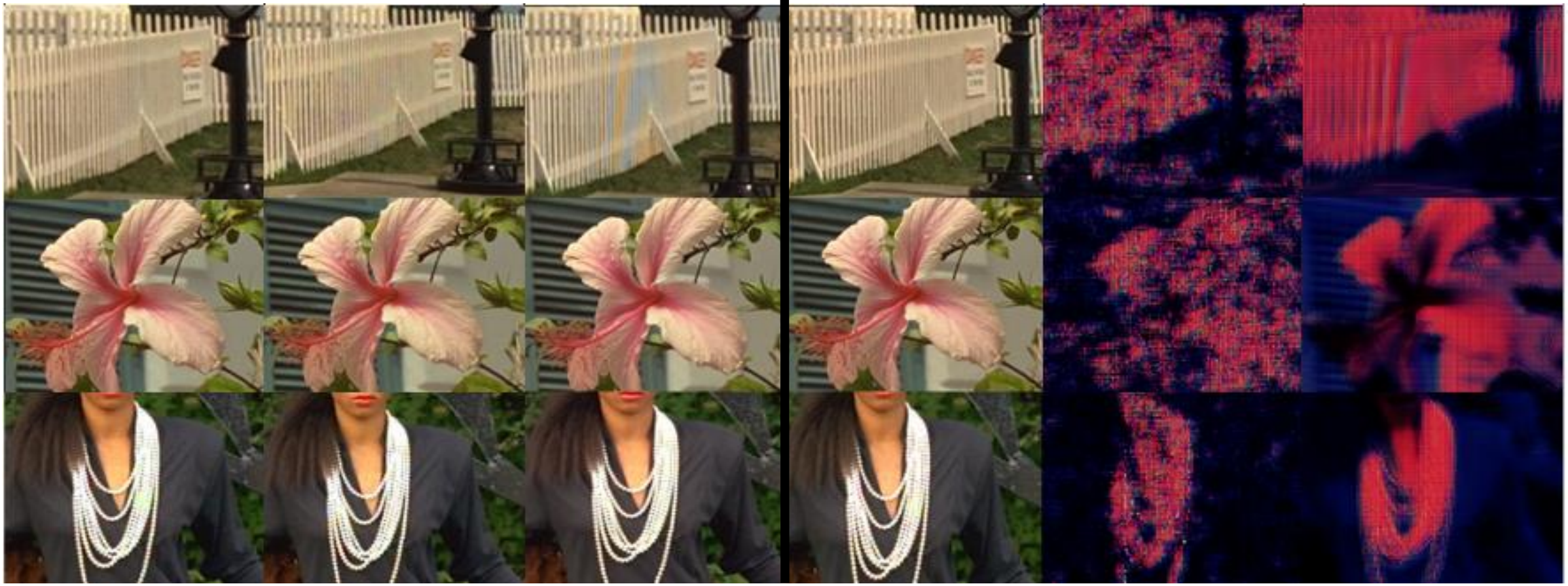
- Cross testing CFA arrangement

Learnt random 

4x4 #2 | New random | Bayer

Learnt periodic 4x4 #2 

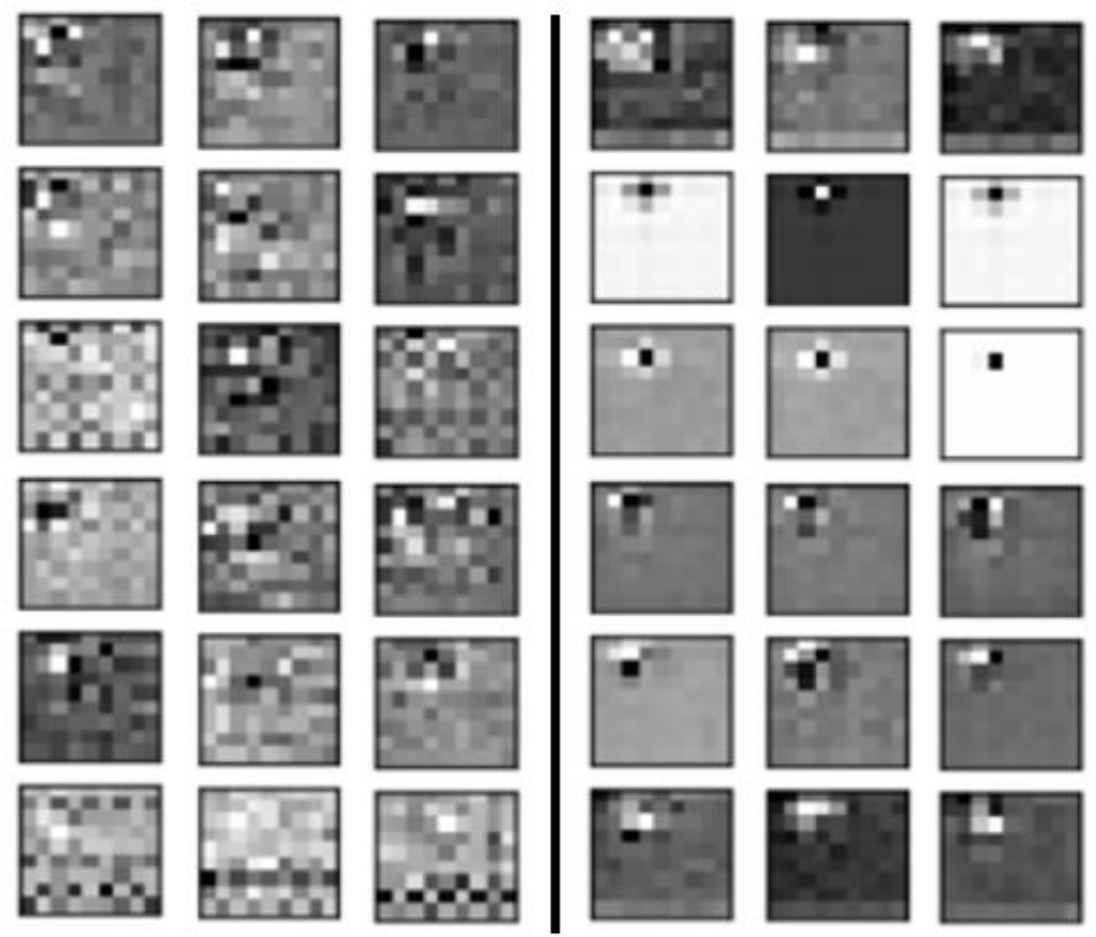
4x4 #2 | New random | Bayer



Why it works ?

- Network found local trajectories

Periodic Learning



Random Learning

Filters of the first convolutional layer

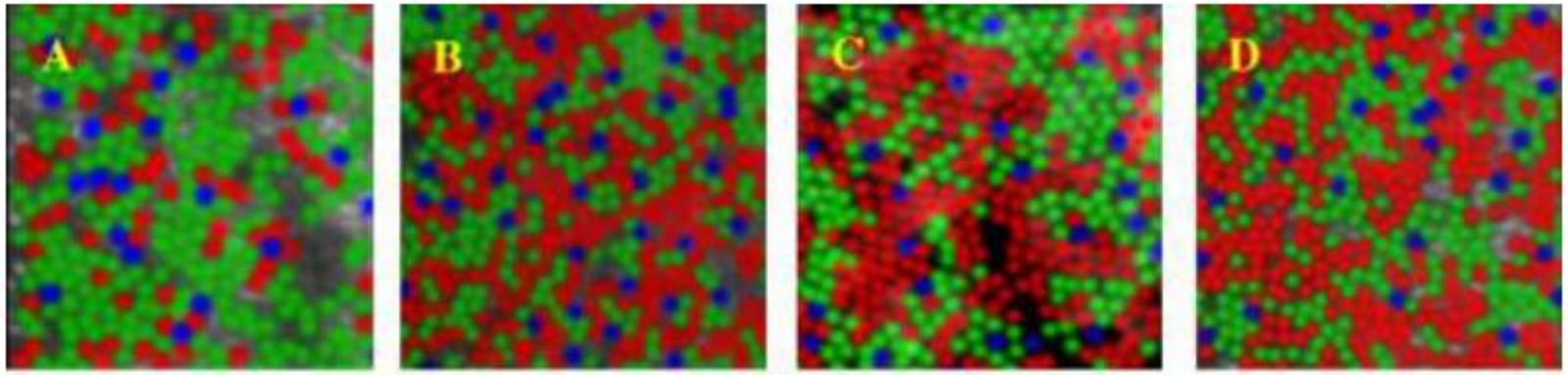
Universality ?

- For a given problem (a particular CFA) optimal solution is found empirically (e.g. Bayer), from adequate processing (i.e. universal demosaicking) and universal processing (a single process for all problems).

	LMMSE	Universal	Our CNN Periodic	Our CNN Random
Same code with different CFA				x
Different code with different CFA	x	x	x	
Deterministic solution	x	x		
Learning capability	x		x	x

What does that mean?

- There probably exists a universal processing for demosaicking. That produces the desire image. A potential candidate for retinal demosaicking. But at the speed of biological process, not CNN.



- A local solution can be efficient solution.
- Relaxing constraints in CFA fabrication.
- Perspective: confirming robustness property against illumination