STRAINER: Learning Transferable Features for Implicit Neural Representations
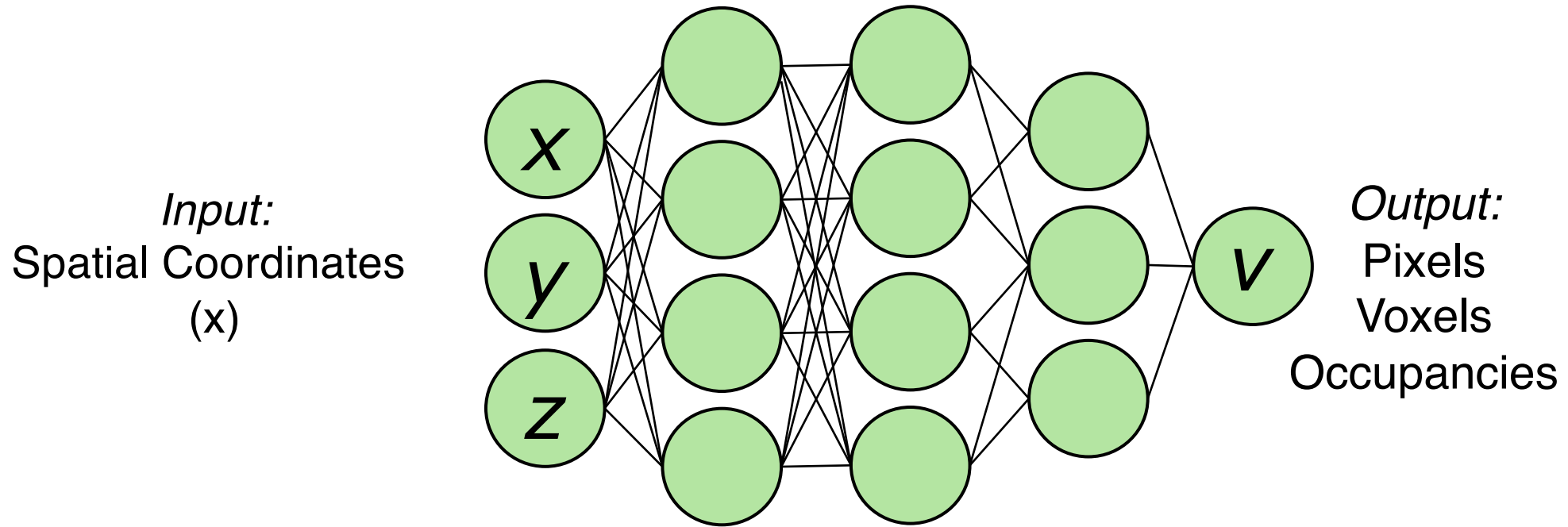
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Rice University, Houston. USA.
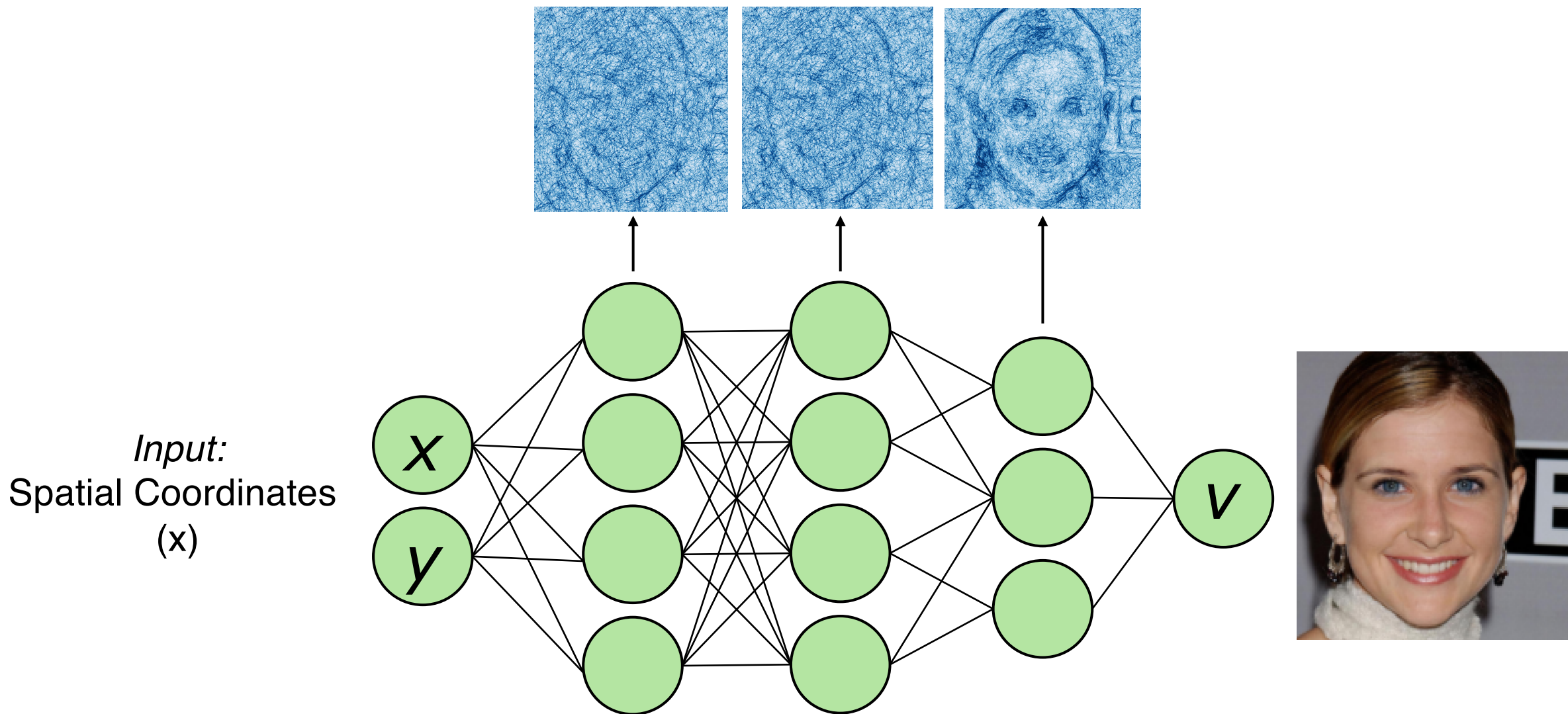
kushalvyas.github.io/strainer.html

Implicit Neural Representations(INRs)
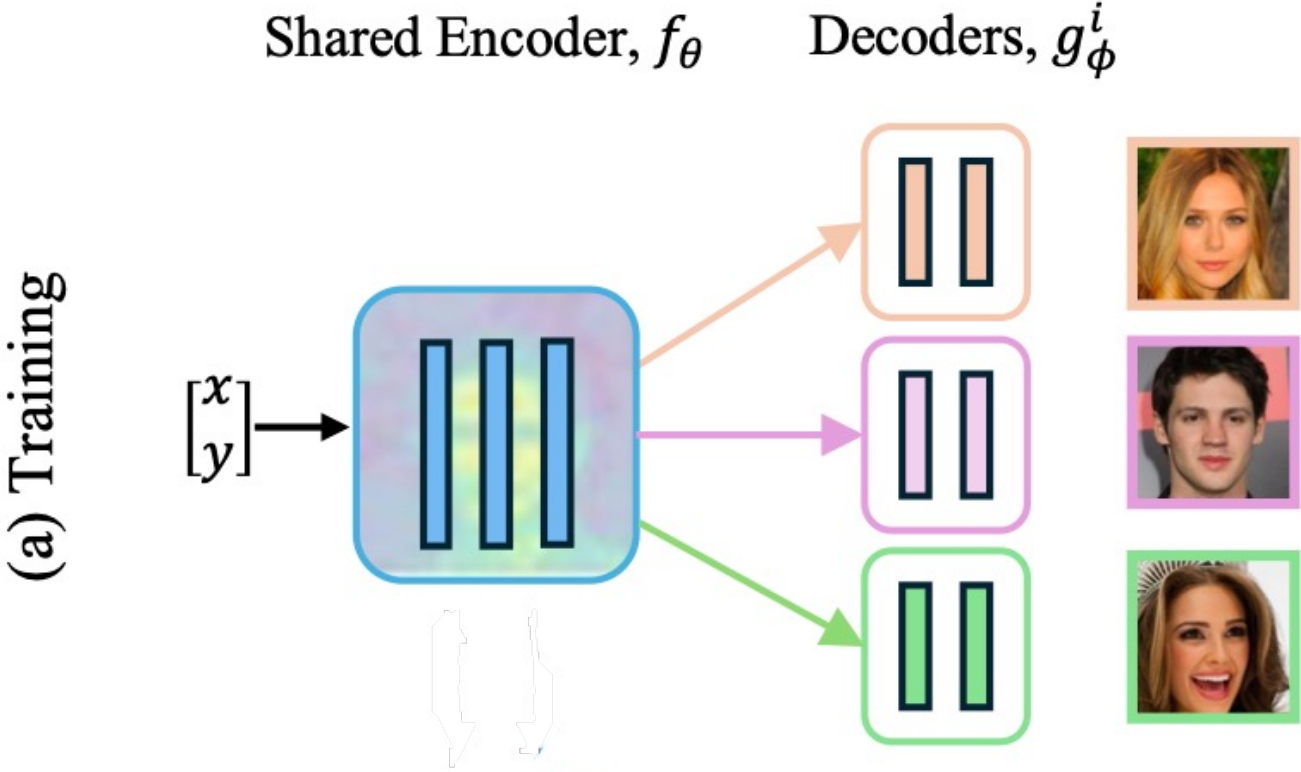
$$v = f_\phi(x, y, z)$$

Input:
Spatial Coordinates
(x)

Output:
Pixels
Voxels
Occupancies

- Signal Specific
- Less generalizable

Input:
Spatial Coordinates
(x)

STRAINER: Learning transferable features for INRs

Shared Encoder, f_θ Decoders, g_ϕ^i

(a) Training

$\begin{bmatrix} x \\ y \end{bmatrix}$

STRAINER: Learning transferable features for INRs

Shared Encoder, f_θ Decoders, g_ϕ^i

(a) Training

$\begin{bmatrix} x \\ y \end{bmatrix}$

(b) Fitting new image

$\begin{bmatrix} x \\ y \end{bmatrix}$

STRAINER: Learning transferable features for INRs

Shared Encoder, f_θ

Decoders, g_ϕ^i

(c) Reconstructed output

(a) Training

$\begin{bmatrix} x \\ y \end{bmatrix}$

(b) Fitting new image

$\begin{bmatrix} x \\ y \end{bmatrix}$

STRAINER   SIREN   Ground Truth

36.35 dB   27.94 dB
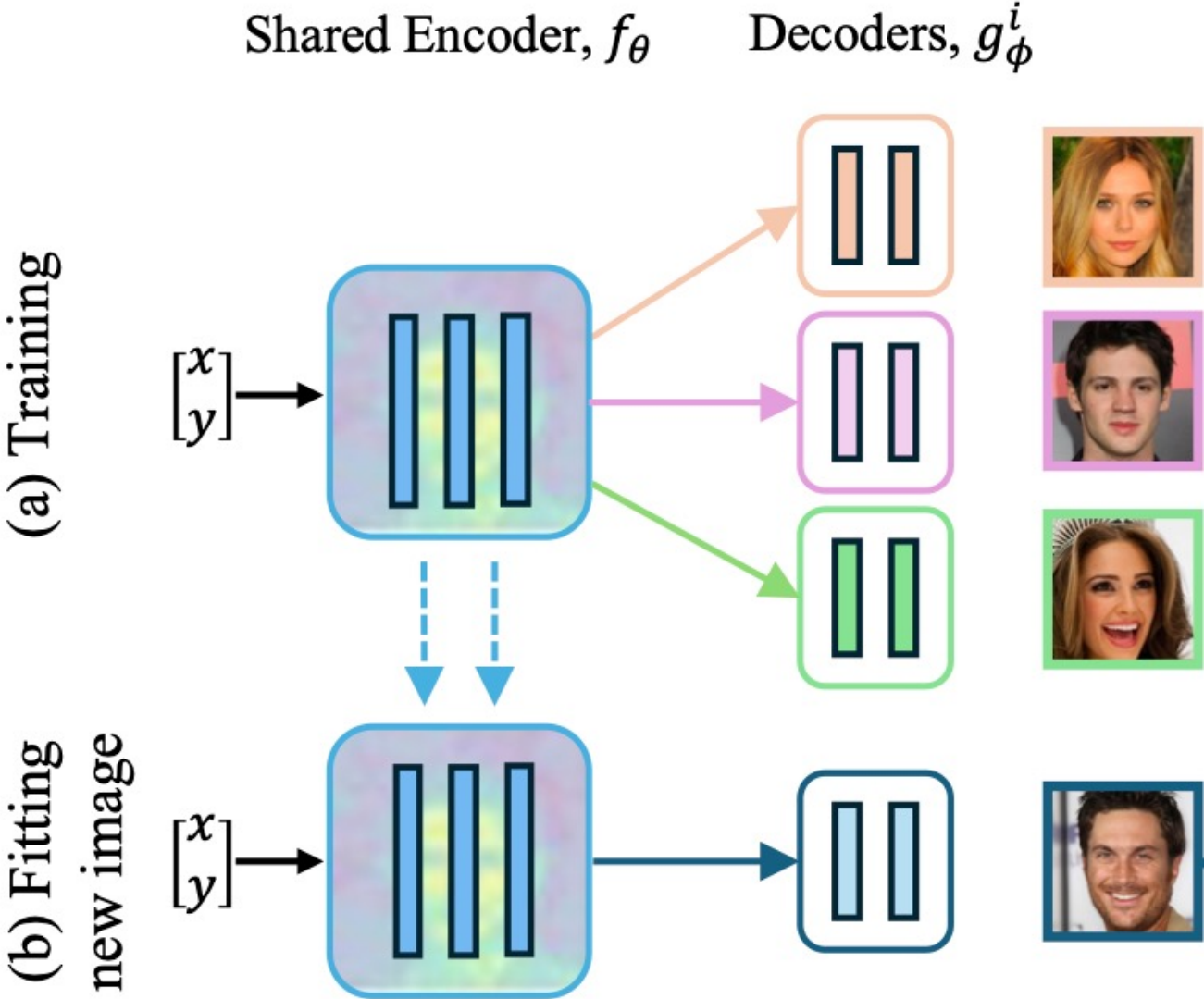
PSNR at 200 iterations
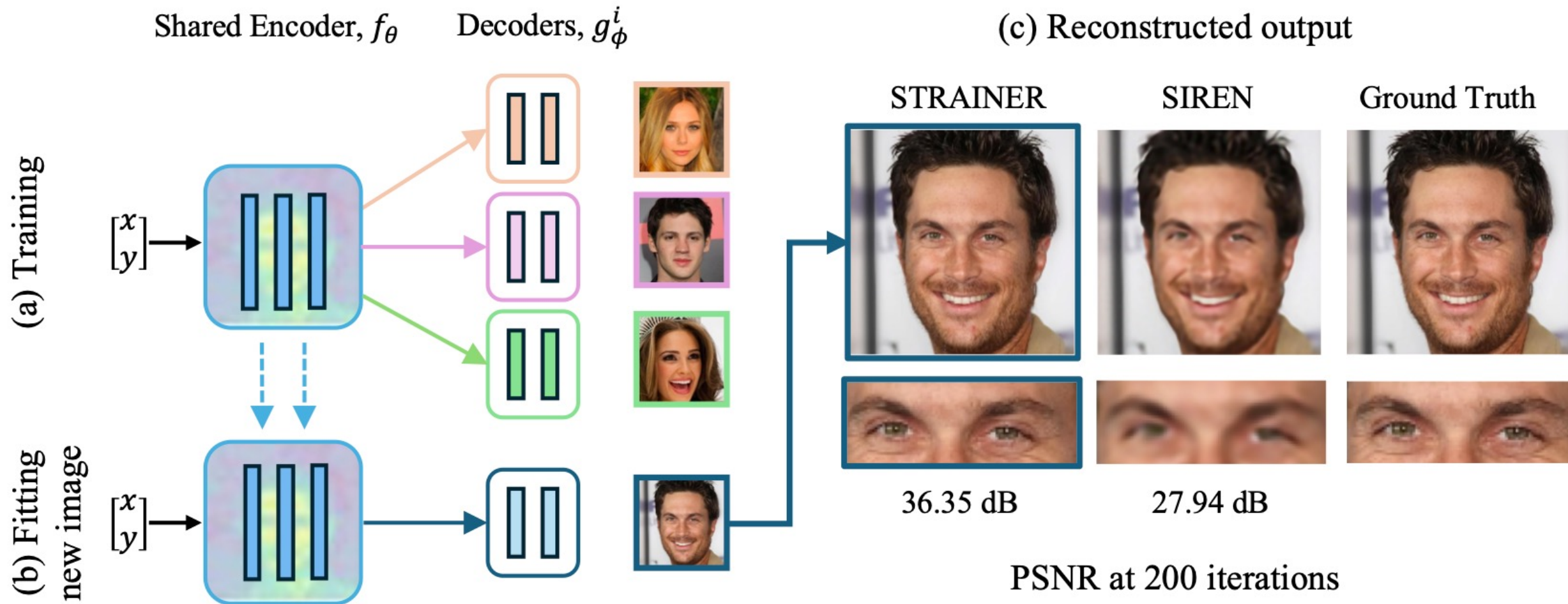
Image Fitting: STRAINER converges fast and with high quality with just 10 training images.
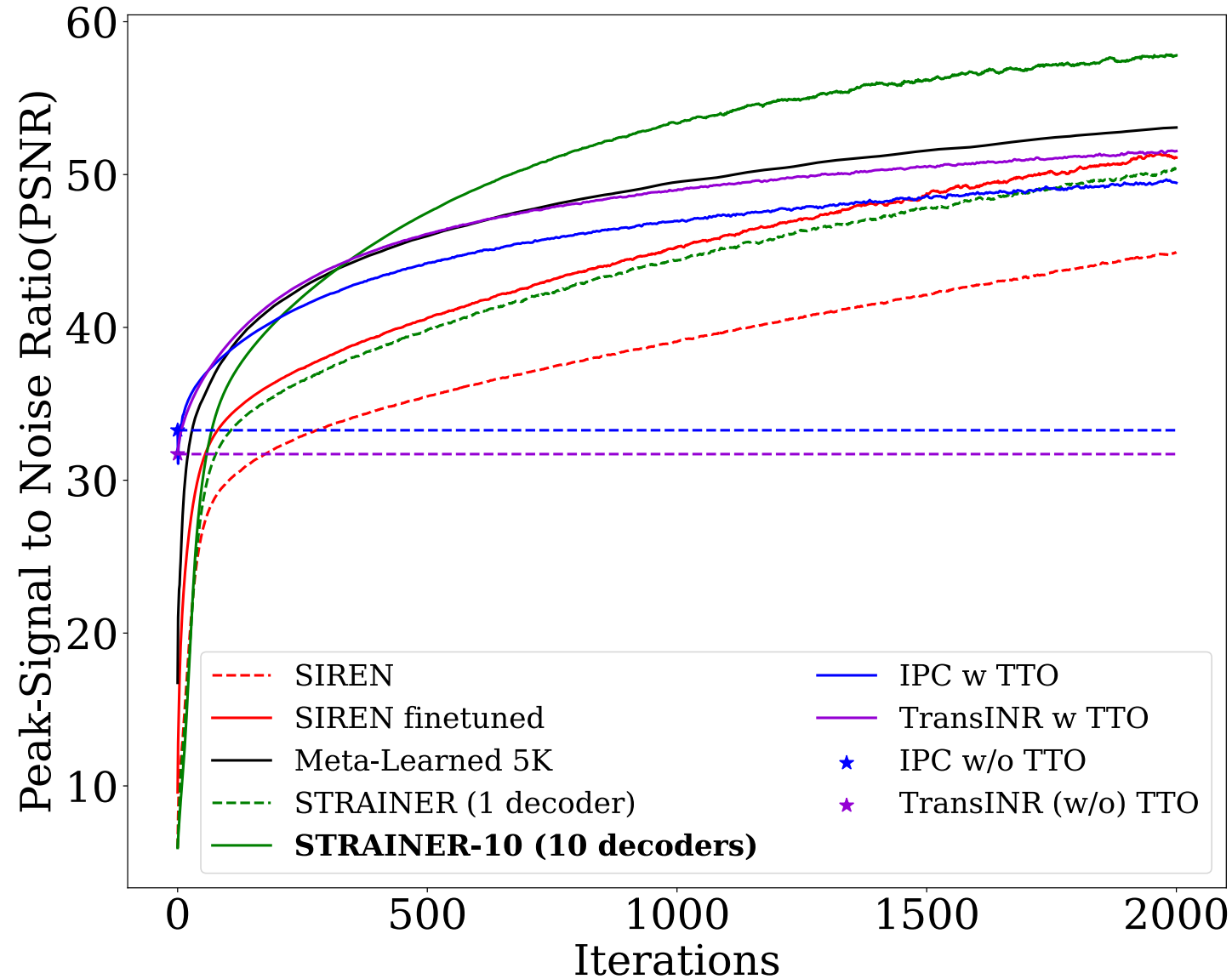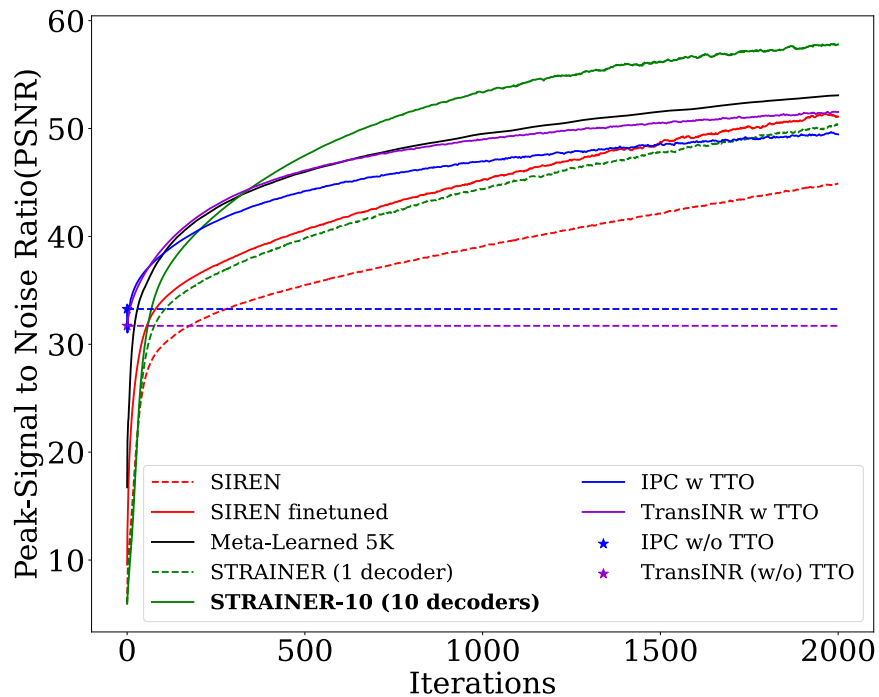
Method	CelebA-HQ (ID) PSNR↑	AFHQ (OOD) PSNR↑	OASIS MRI (OOD) PSNR↑
Meta-learned 5K	53.08	52.40	55.86
Trans INR w/o TTO	31.59	28.63	31.97
Trans INR w TTO	51.86	49.01	55.45
IPC(ReLU + Pos Enc.) w/o TTO	33.27	29.96	33.96
IPC(ReLU + Pos Enc.) w TTO	49.72	47.19	51.35
STRAINER-10	**57.80**	**57.46**	59.50
STRAINER-10 (trained on Flowers[1])	-	56.98	58.52
STRAINER-10 (trained on StanfordCars[2])	-	56.88	**59.66**

STRAINER converges rapidly for inverse problems

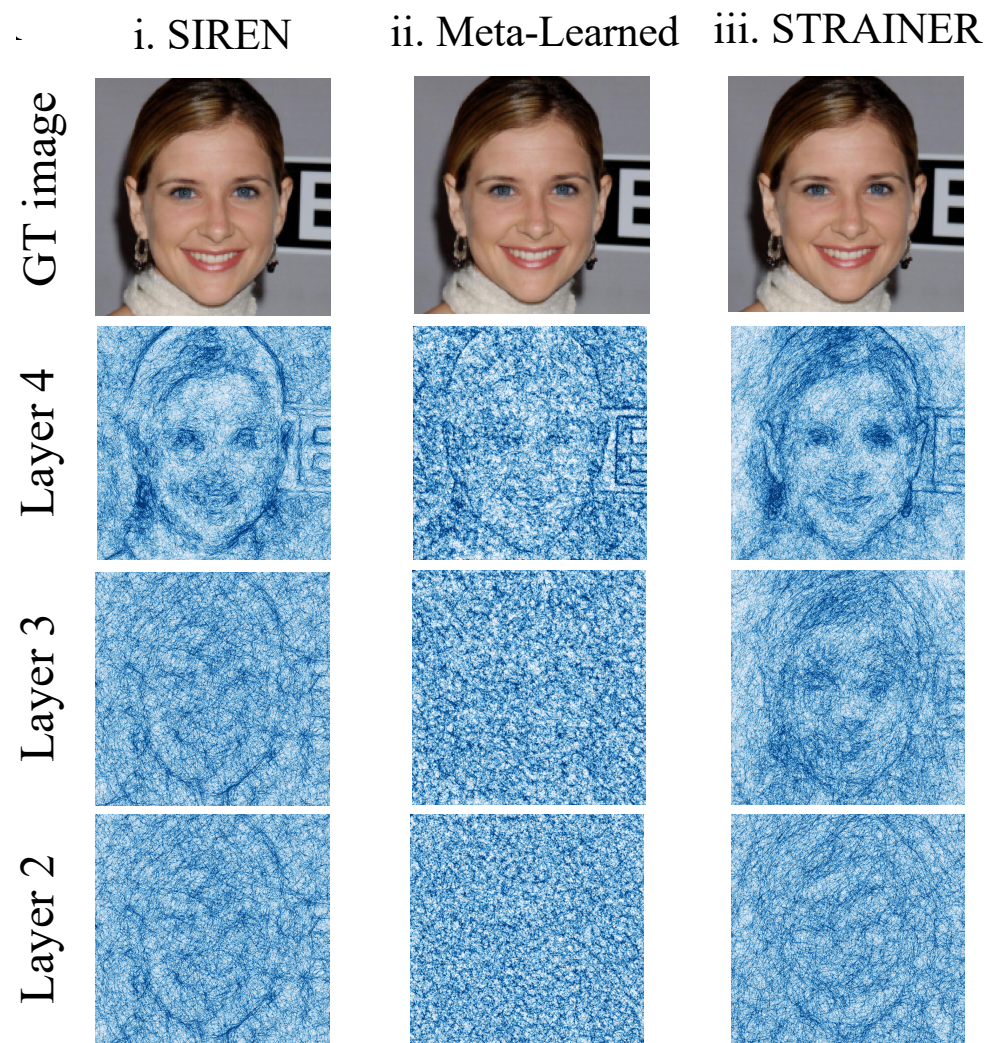| Method	Super Resolution (Fast)		Denoising	
	PSNR	# iterations	PSNR	# iterations
SIREN	32.10	3329	26.75 ± 1.67	203 ± 66
STRAINER -10	31.56	$1102\ (\approx 3 \times faster)$	26.41 ± 1.39	76 ± 27

Speedup means interesting priors have been encoded!

Visualizing STRAINER partition geometry in input space

(a) Initialization

i. Meta-Learned 5K   ii. STRAINER

(b) Fitting new image

i. SIREN   ii. Meta-Learned   iii. STRAINER

Generated

GT image

Layer 4

Layer 3

Layer 2
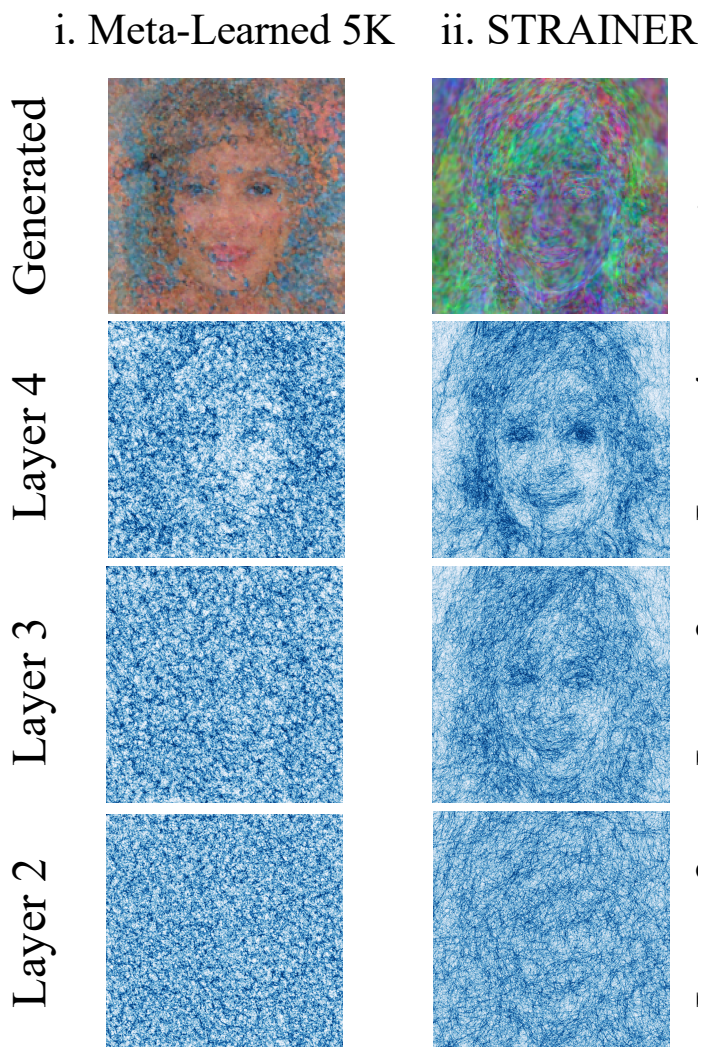
STRAINER learns blazing fast!

Method	# training images	Gradient updates / iteration	Time (Nvidia A100)
SIREN	N/A	N/A	N/A
STRAINER (1 decoder)	1	264,707	11.84s
STRAINER-10 (10 decoders)	10	271,646	24.54s
Meta-learned 5K	10	794,121 ($\approx 3\times$ more)	1432.3s = 23.8 min
TransINR[9]	14,000	$\approx 40M$	≈ 1 day
IPC[23] w TTO	14,000	$\approx 40M$	≈ 1 day

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For more details:

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