

Reproduce Fast Upsampling

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Outline

1. Current Progress
2. Fast Upsampling Review
3. Implementation Detail
4. Thoughts

1. Current Progress

Origin



Mine



Ground truth



1. Current Progress

Origin



Mine



Ground truth



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2. Fast Upsampling Review

- Image formation process

$$L = (f \otimes H) \downarrow^d$$

Diagram illustrating the image formation process equation:

L is labeled as the low-resolution image.

f is labeled as the PSF (i.e. kernel).

H is labeled as the high-resolution image.

\downarrow^d is labeled as the subsampling factor.

2. Fast Upsampling Review

- Image formation process

$$\textcolor{red}{H} = (f \otimes \textcolor{red}{L}) \downarrow^d$$

2. Fast Upsampling Review

- Image formation process

$$H = (f \otimes L \uparrow^d)$$

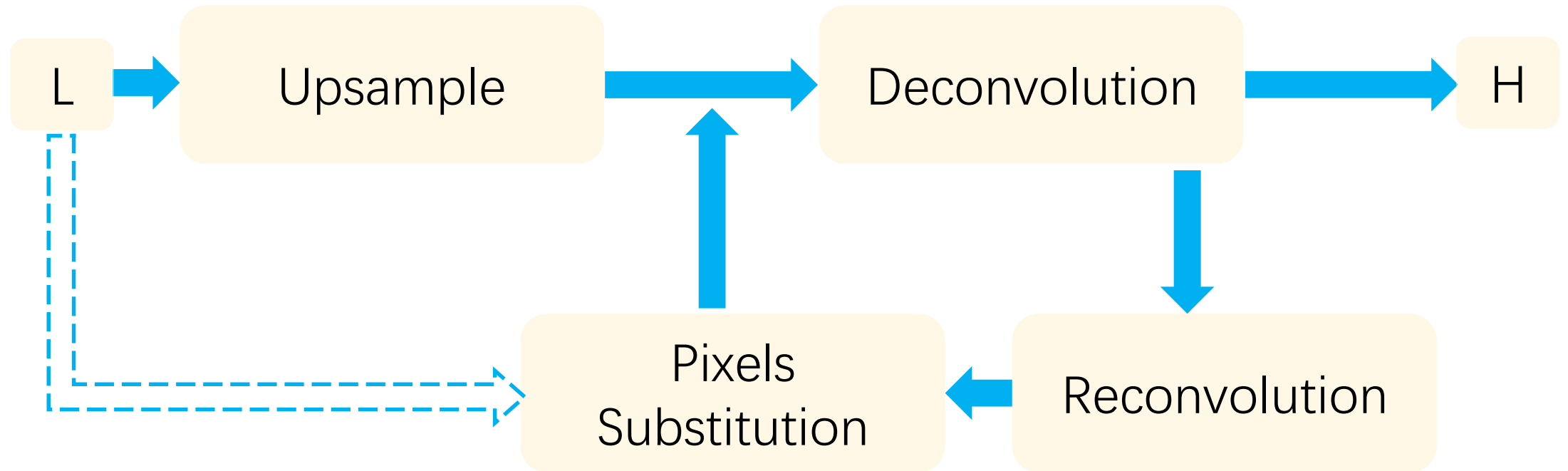
2. Fast Upsampling Review

- Image formation process

$$H = (f \otimes^{-1} L \uparrow^d)$$

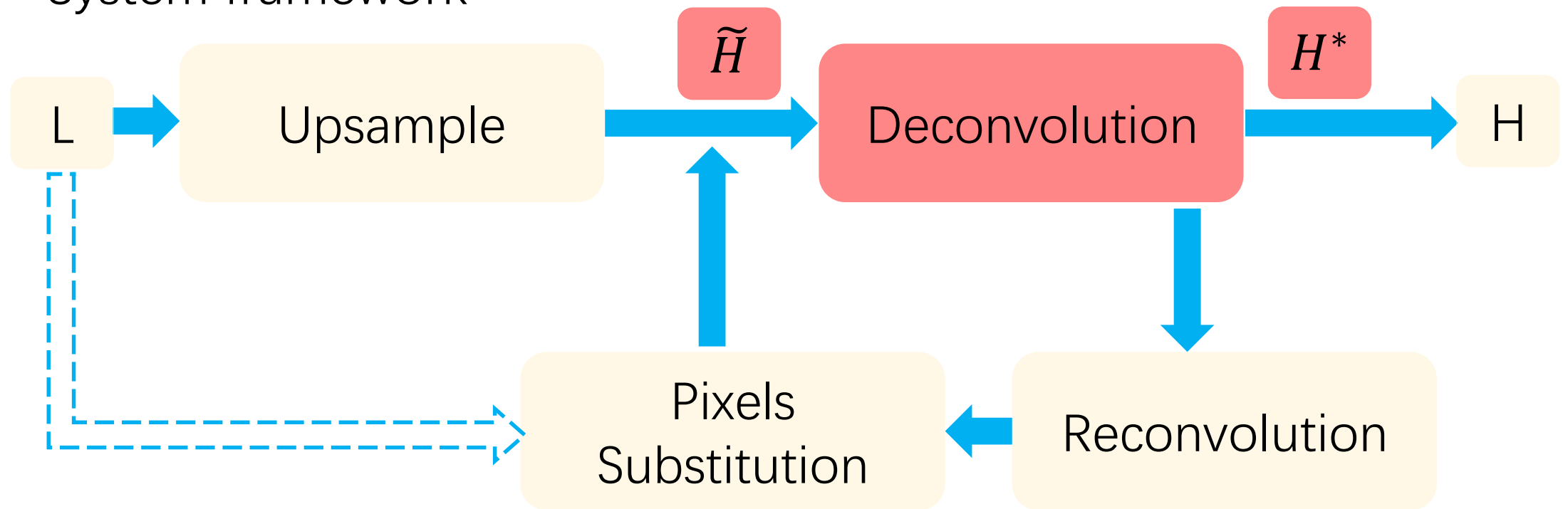
2. Fast Upsampling Review

- System framework



2. Fast Upsampling Review

- System framework



2. Fast Upsampling Review

- Non-blind deconvolution

$$E(H^*) \propto \|f \otimes H^* - \tilde{H}\|_2^2 \quad \text{—— fidelity term}$$

$$\text{regularization term} \quad \text{——} \quad +\lambda_1 (\|\Phi(\partial_x H^*)\|_1 + \|\Phi(\partial_y H^*)\|_1)$$

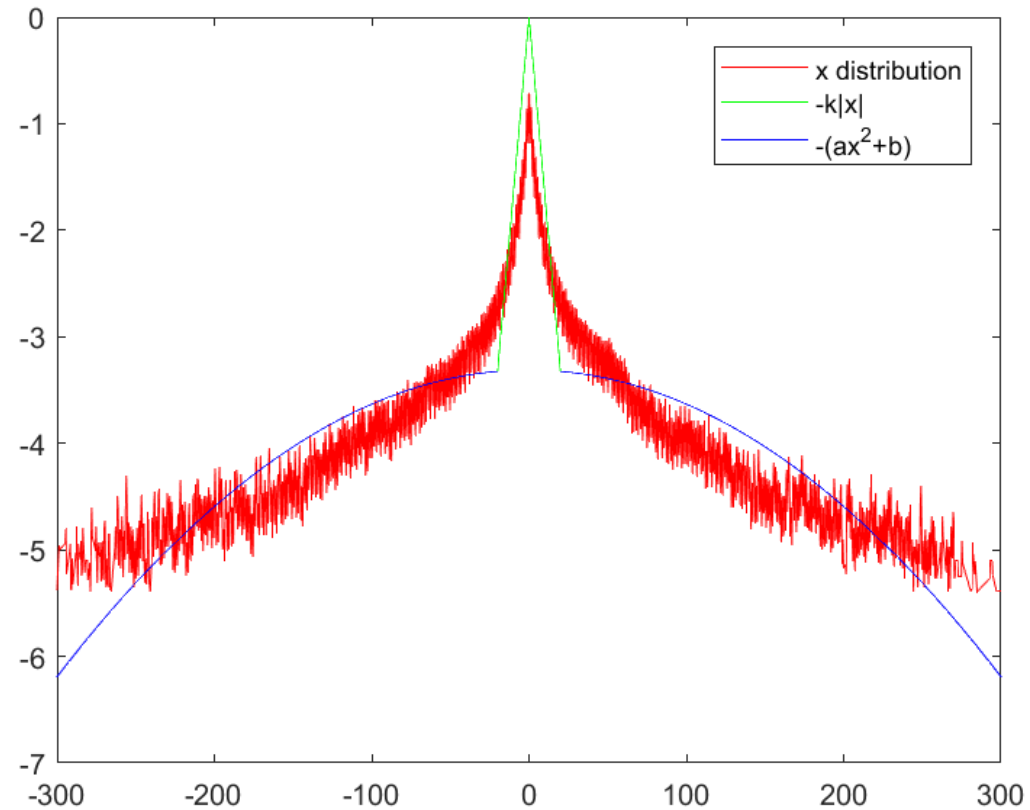
2. Fast Upsampling Review

- Image gradient density distribution prior

$$E(H^*) \propto \|f \otimes H^* - \tilde{H}\|_2^2 \quad \text{fidelity term}$$

regularization term — $+ \lambda_1 (\underbrace{\|\Phi(\partial_x H^*)\|_1}_{\text{penalty}} + \|\Phi(\partial_x H^*)\|_1)$

2. Fast Upsampling Review



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3. Implementation Detail

- Variable substitution

$$\begin{aligned} E(H^*) \propto & \|f \otimes H^* - \tilde{H}\|_2^2 \\ & + \lambda_1 (\|\Phi(\mu_x)\|_1 + \|\Phi(\mu_y)\|_1) \\ & + \lambda_2 (\|\mu_x - \partial_x H^*\|_2^2 + \|\mu_y - \partial_y H^*\|_2^2) \end{aligned}$$

3. Implementation Detail

- Variable substitution

$$\begin{aligned} E(H^*) \propto & \|f \otimes H^* - \tilde{H}\|_2^2 \\ & + \lambda_1 (\|\Phi(\mu_x)\|_1 + \|\Phi(\mu_y)\|_1) \\ & + \lambda_2 (\|\mu_x - \partial_x H^*\|_2^2 + \|\mu_y - \partial_y H^*\|_2^2) \end{aligned}$$

3. Implementation Detail

- Optimize $E(H^*)$

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3. Implementation Detail

- Optimize $E(\mu)$

$$\begin{aligned} E(\mu) \propto & \|f \otimes H^* - \tilde{H}\|_2^2 \\ & + \lambda_1 (\|\Phi(\mu_x)\|_1 + \|\Phi(\mu_y)\|_1) \\ & + \lambda_2 (\|\mu_x - \partial_x H^*\|_2^2 + \|\mu_y - \partial_y H^*\|_2^2) \end{aligned}$$

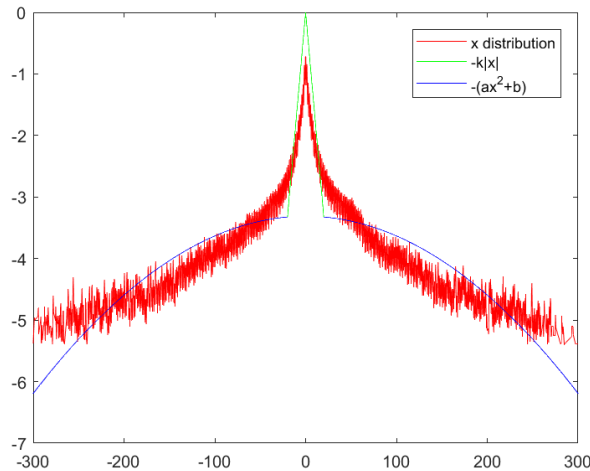
3. Implementation Detail

- Optimize $E(\mu)$

$$\begin{aligned} E(\mu) \propto & \|f \otimes H^* - \tilde{H}\|_2^2 \\ & + \lambda_1 (\|\Phi(\mu)\|_1) \\ & + \lambda_2 (\|\mu - c\|_2^2) \end{aligned}$$

3. Implementation Detail

- Optimize $E(\mu)$



$$\mu = \mathbf{c} - \frac{\lambda_1 k}{2\lambda_2}$$
$$\mu = \mathbf{c} + \frac{\lambda_1 k}{2\lambda_2}$$
$$\mu = \frac{\lambda_2 \mathbf{c}}{\lambda_1 a + \lambda_2}$$

when $0 \leq \mu < l_t$

when $-l_t < \mu < 0$

when $\mu \geq l_t$ or $\mu \leq -l_t$

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5. Thoughts

- Image restoration is challenging!
- Many questions are ill-posed and therefore need constraints.
- Knowledge about Machine Learning.
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Thank you!