MetaStyle: Three-Way Trade-Off Among Speed, Flexibility and Quality in Neural Style Transfer

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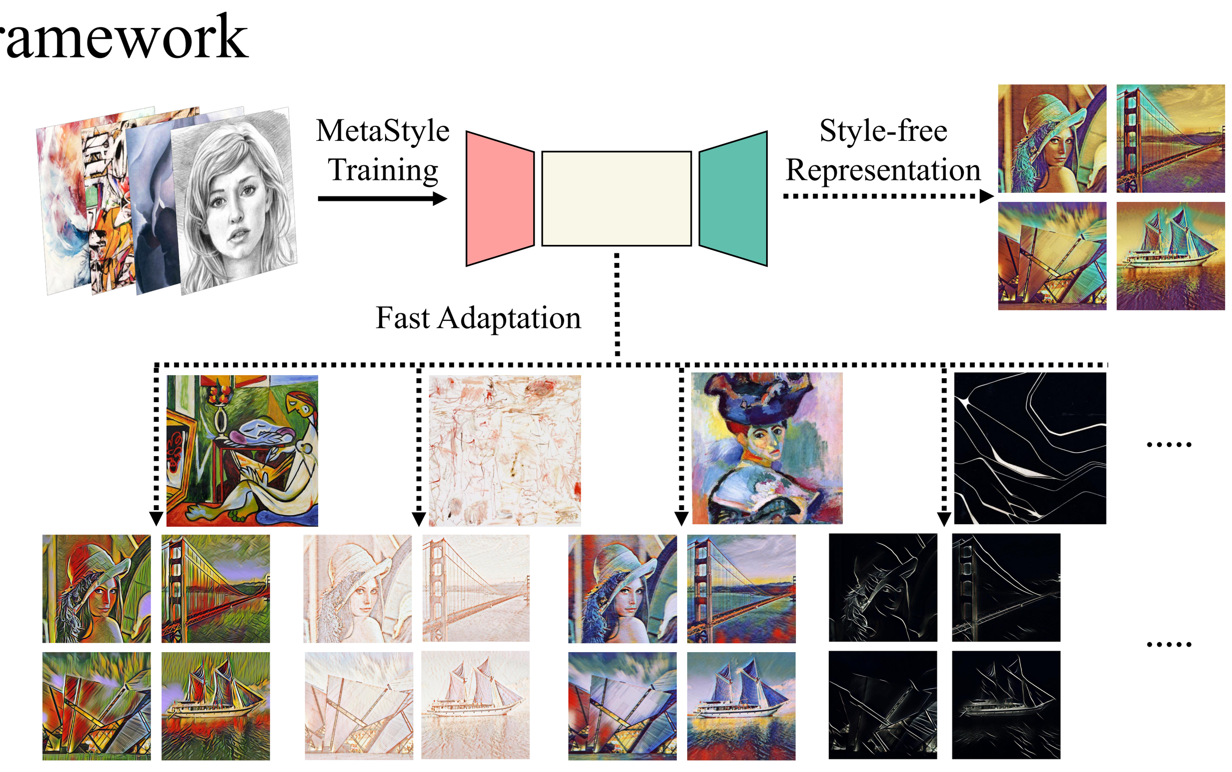
Motivation

Method	Speed	Flexibility	Quality	Drawback
Optimization-based	Slow	Any	High	Run for each content-style pair
Fast approximation	Fast	Single	High	Train long for each new style
Feature matching	Fast	Any/Several	Compromised	Limited set of styles, low quality

Can we find a style transfer algorithm that could quickly adapt to any style, while the adapted model maintains high efficiency and good image quality?

MetaStyle

- Framework



- Training

$$\underset{\theta}{\text{minimize}} \quad \mathbb{E}_{c,s}[\ell(I_c, I_s, M(I_c; w_{s,T}))]$$

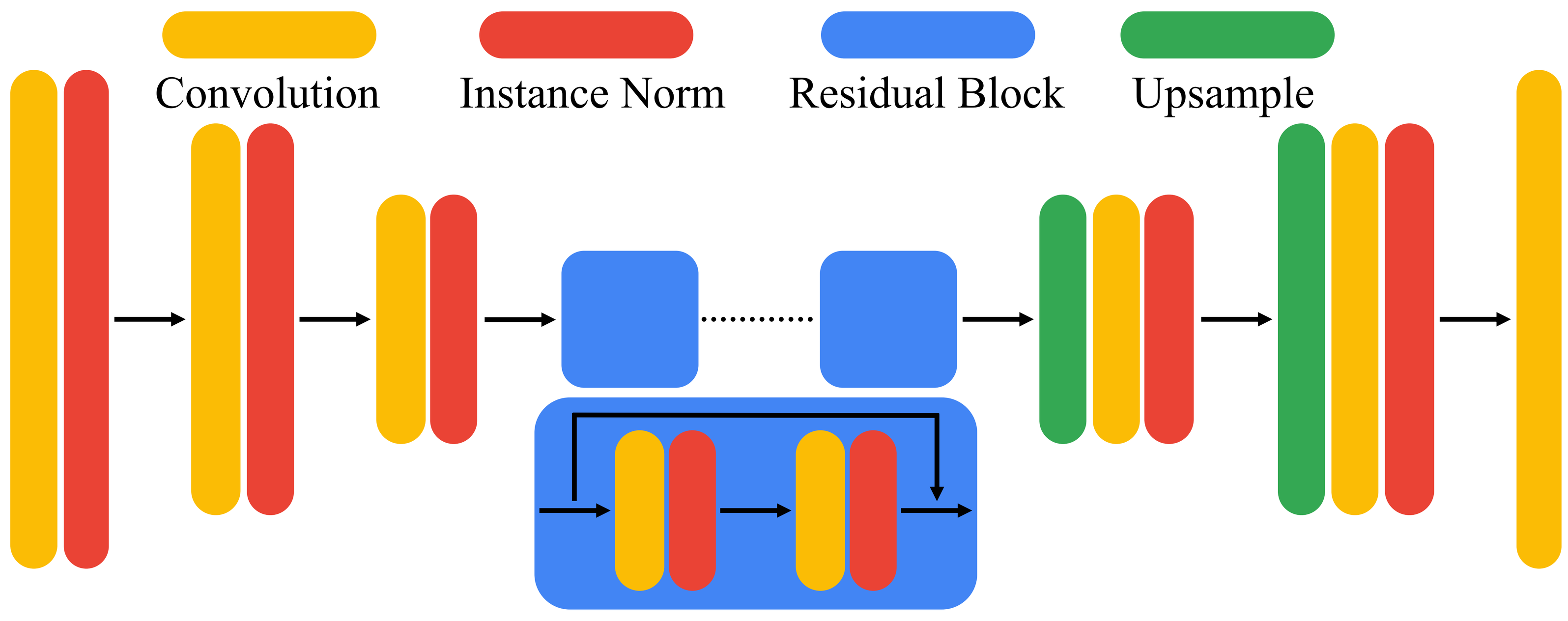
$$\text{subject to} \quad w_{s,0} = \theta$$

$$w_{s,t} = w_{s,t-1} - \delta \nabla \mathbb{E}_c[\ell(I_c, I_s, M(I_c; w_{s,t-1}))]$$

- Adaptation

$$\underset{w}{\text{minimize}} \quad \mathbb{E}_c[\ell(I_c, I_s, M(I_c; w)]$$

Network



Algorithm

Algorithm 1: MetaStyle

Input : content training dataset $\mathcal{D}_{tr}$, content validation dataset $\mathcal{D}_{val}$, style dataset $\mathcal{D}_{style}$, inner learning rate δ, outer learning rate η, number of inner updates T

Output: trained parameters θ

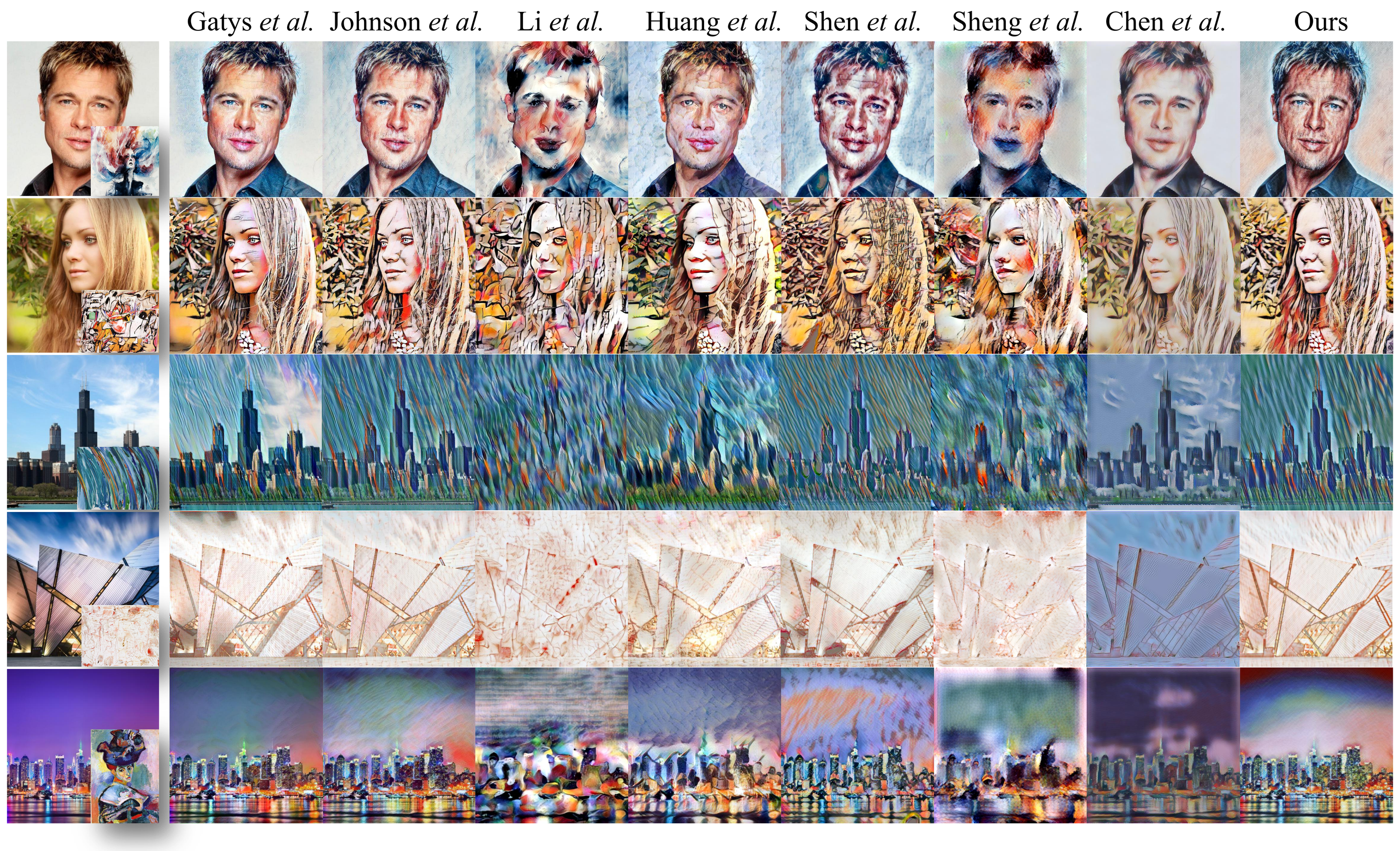
```
randomly initialize θ
while not done do
    initialize outer loss E ← 0
    sample a batch of styles from D_style
    for each style I_s do
        w_s ← θ
        for i ← 1 to T do
            sample a batch B_tr from D_tr
            compute inner loss L_θ using I_s and B_tr
            w_s ← w_s − δ∇L_θ
        end
        sample a batch B_val from D_val
        increment E by loss from I_s and B_val
    end
    θ ← θ − η∇E
end
```

Quantitative Results

Method	Param	256 (s)	512 (s)	# Styles
Gatys *et al.*	N/A	7.7428	27.0517	∞
Johnson *et al.*	**1.68M**	**0.0044**	**0.0146**	1
Li *et al.*	34.23M	0.6887	1.2335	∞
Huang *et al.*	7.01M	0.0165	0.0320	∞
Shen *et al.*	219.32M	**0.0045**	**0.0147**	∞
Sheng *et al.*	147.22M	0.5089	0.6088	∞
Chen *et al.*	**1.48M**	0.2679	1.0890	∞
Ours	**1.68M**	**0.0047**	**0.0145**	$\infty^{\star}$

Qualitative Results

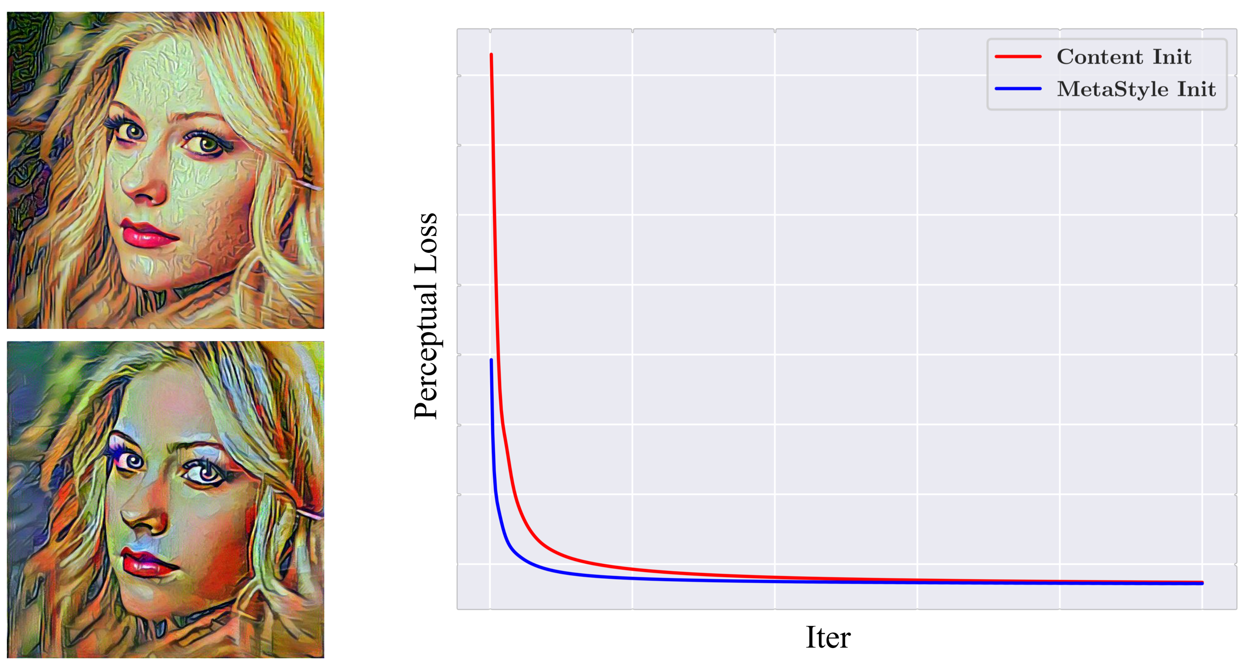
- Comparison with Existing Methods



- Style Interpolation

- Video Style Transfer

- Comparison to Gatys *et al.* with MetaStyle Init



- Comparison to Johnson *et al.* with MetaStyle