High Fidelity Guided Image Synthesis using Latent Diffusion Models

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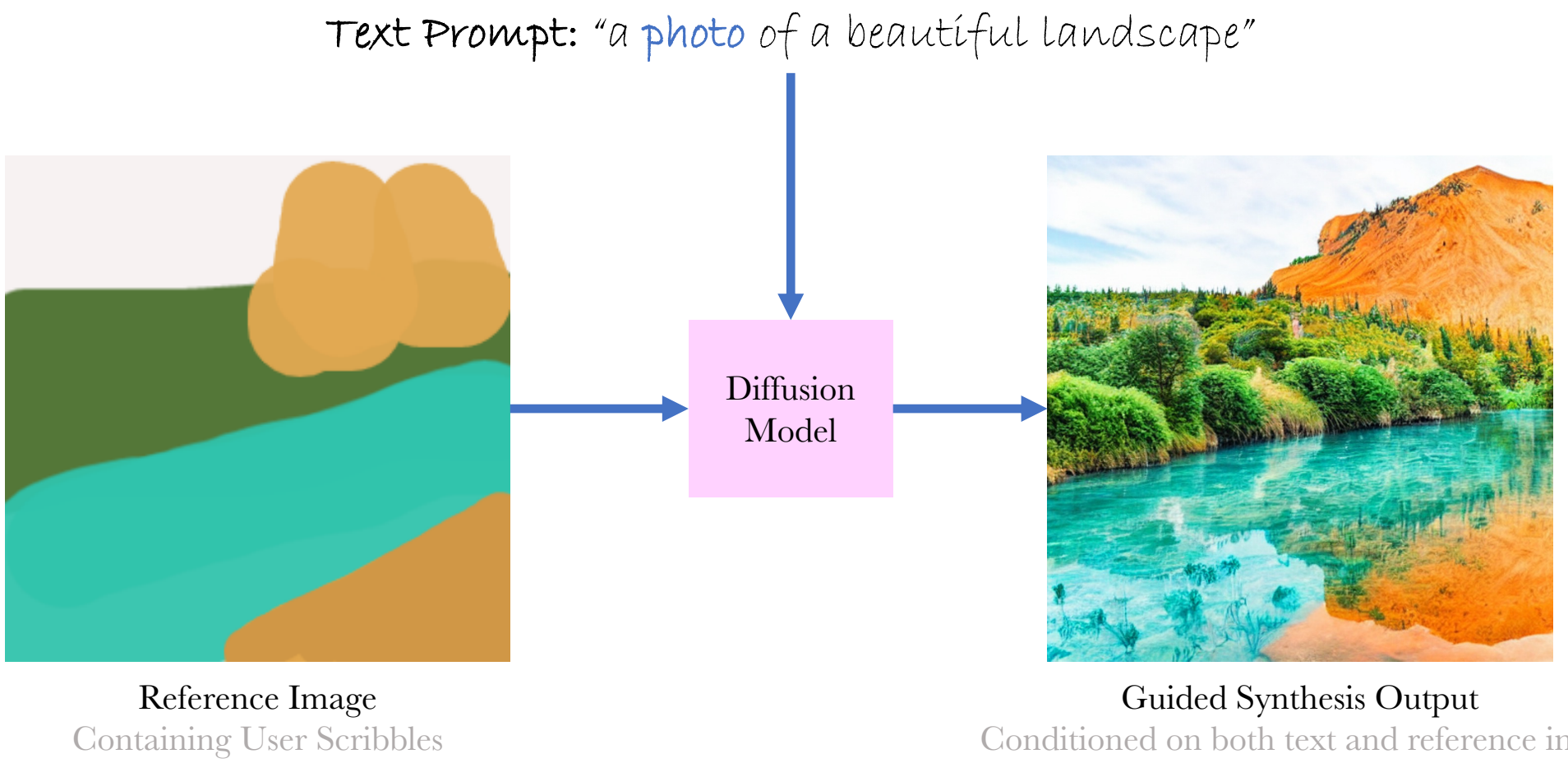
Poster Tag: TUE-PM-179

Guided Image Synthesis with User Scribbles



Text Prompt: "a photo of a beautiful landscape"




Text-Conditioned Image Outputs

Text Prompt: "a photo of a beautiful landscape"




Text-Conditioned Image Outputs

Text Prompt:
"a photo of a beautiful landscape"

Reference Painting




SDEdit

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Text Prompt:
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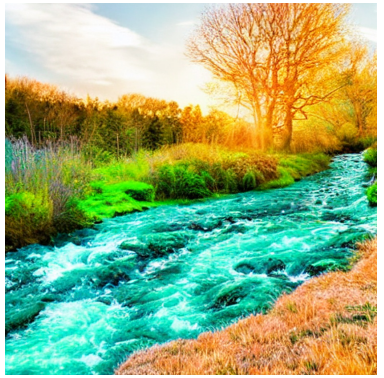
Reference Painting




SDEdit






GradOP (Ours)

Controlling Semantics of Different Painting Regions

Text Prompt: "a photo of a beautiful landscape"

GradOP: Constrained Optimization Solution

Text Prompt: "a photo of a red tiger in a green field"

Reference: y

GradOP: Constrained Optimization Solution

Text Prompt: "a photo of a red tiger in a green field"

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Target Subspace

conditioned only on text

$\mathcal{S}_{\tau_{text}}$

GradOP: Constrained Optimization Solution

Text Prompt: "a photo of a red tiger in a green field"

Reference: y

$$x^\star = \text{argmin}_x \ \mathcal{L}\left(f(x), y\right)$$
$$s.t. \quad x \in \mathcal{S}_{\tau_{text}}$$

Constrained Optimization Formulation

Target Subspace

conditioned only on text

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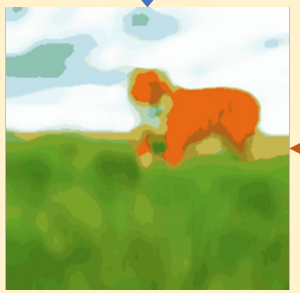
$\mathcal{L}(f(x), y)$

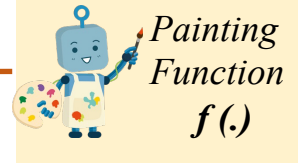


$f(x)$

Painting Reconstruction

$$x^\star = \text{argmin}_x \ \mathcal{L}(f(x), y)$$
$$s.t. \quad x \in \mathcal{S}_{\tau_{text}}$$

Constrained Optimization Formulation



Painting Function $f(.)$

$\mathcal{S}_{\tau_{text}}$

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GradOP Optimization

$\tilde{x}^\star$

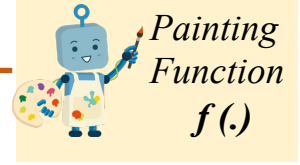
$$\tilde{x}^\star = \text{argmin}_x \; \mathcal{L}(f(x), y) + \gamma \; d(x, x_\tau)$$

Unconstrained Optimization Approximation

$\mathcal{L}(f(x), y)$

$f(x)$

Painting Reconstruction



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$\mathcal{L}(f(x), y)$

$f(x)$

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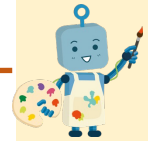

Painting Function f(.)

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conditioned only on text

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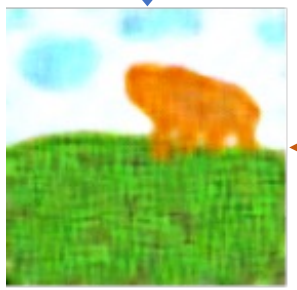
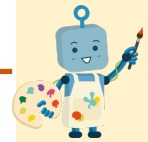
$\mathcal{L}(f(x), y)$



$f(x)$

Painting Reconstruction



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Unconstrained Optimization Approximation

DDIM Inversion

Target Subspace

conditioned only on text

$\mathcal{S}_{\tau_{text}}$

$\tilde{x}^\star$

Forward Diffusion

x_{t_0}

x_t

$\cdots$

$x^\star$

Output Image

GradOP: Constrained Optimization Solution

Text Prompt: "a photo of a red tiger in a green field"

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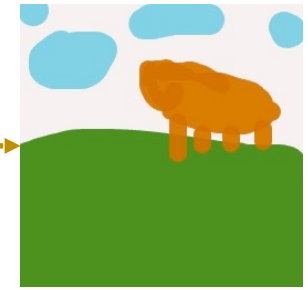

Target Subspace

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High Domain Gap

GradOP: Constrained Optimization Solution

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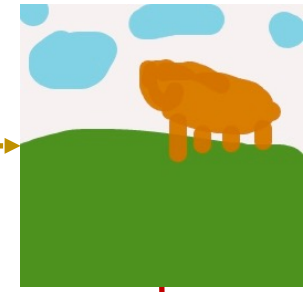
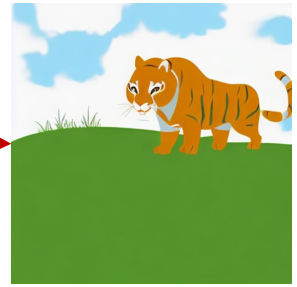
Reference: y



SDEdit



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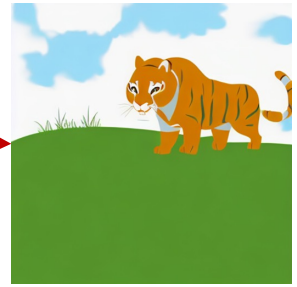

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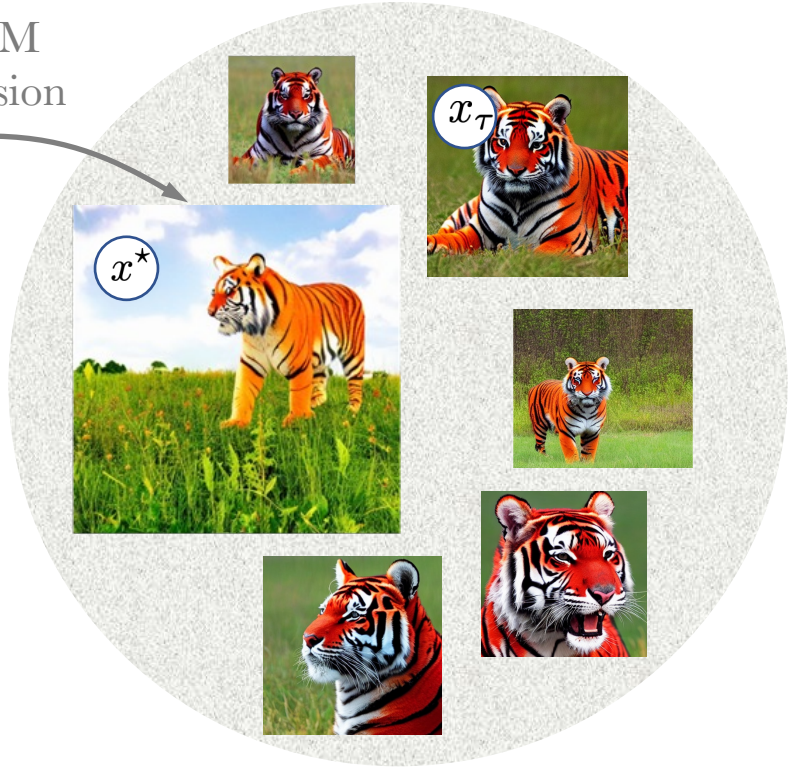
$\tilde{x}^\star$

DDIM Inversion

Target Subspace

conditioned only on text



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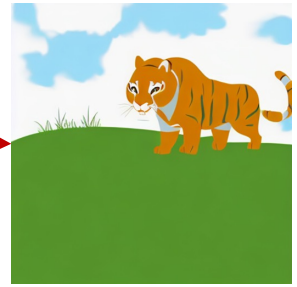
Unconstrained Optimization Approximation

SDEdit



$\mathcal{S}_{\tau_{text}}$

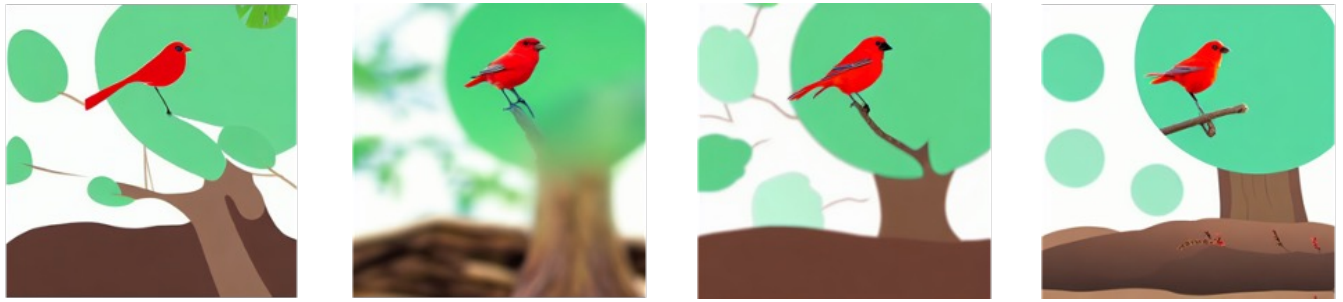
High Domain Gap

Text Prompt: "a photo of a red bird in a tree"

Target Subspace

Text Prompt:
"a photo of a red bird in a tree"

Reference Painting



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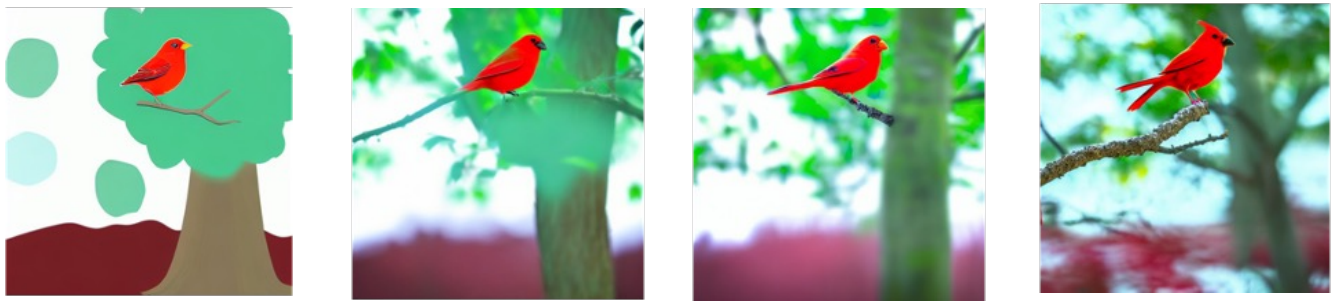
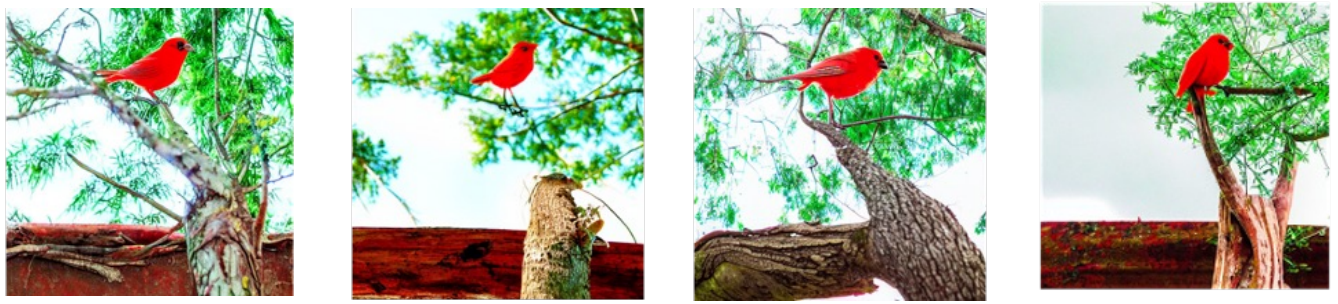


Iterative Loopback



GradOP (Ours)

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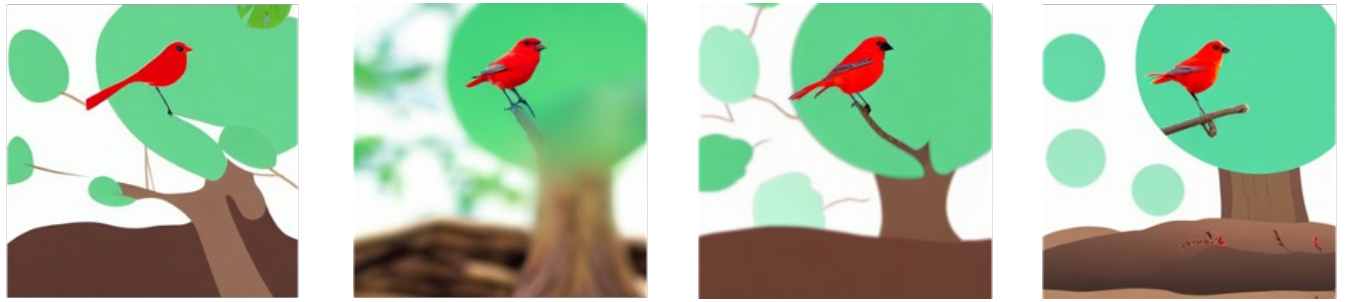

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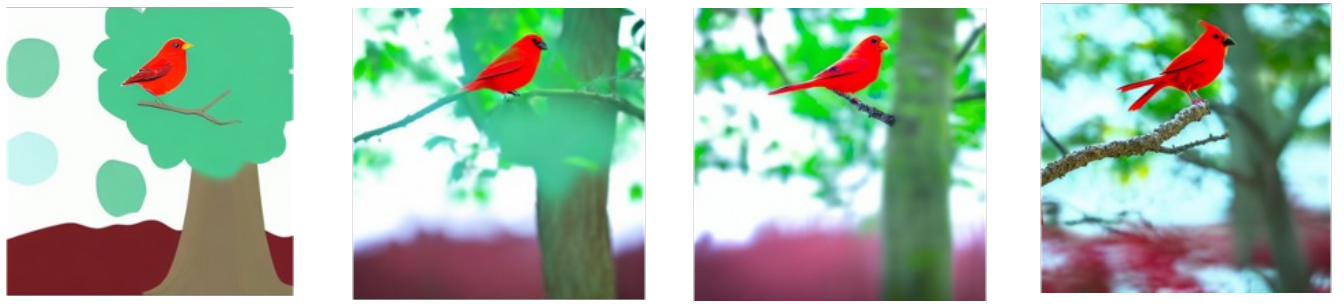

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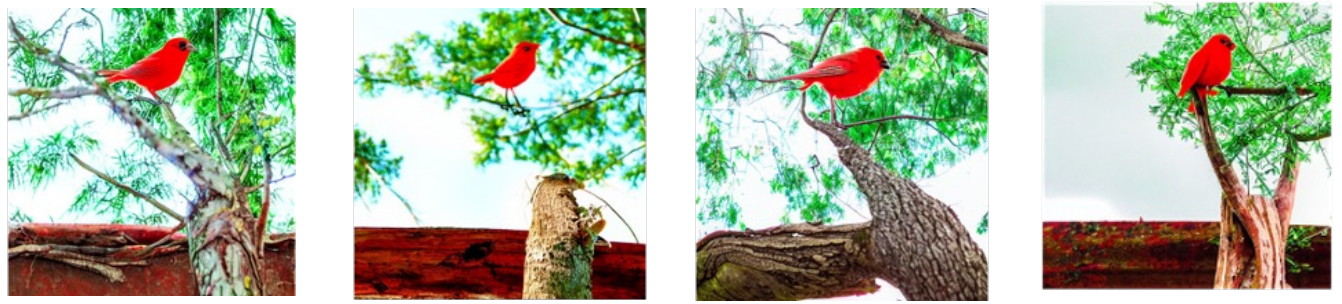

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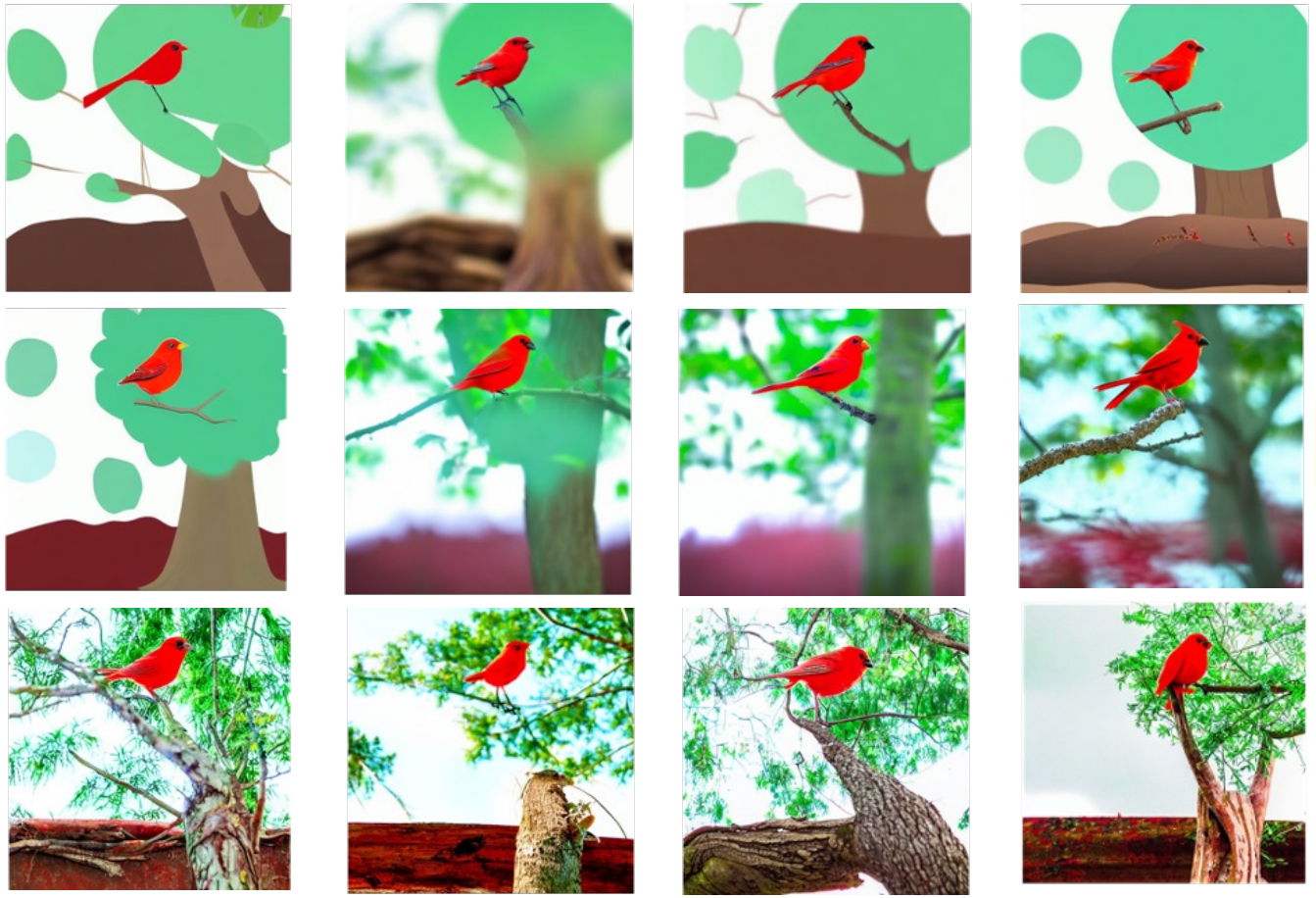

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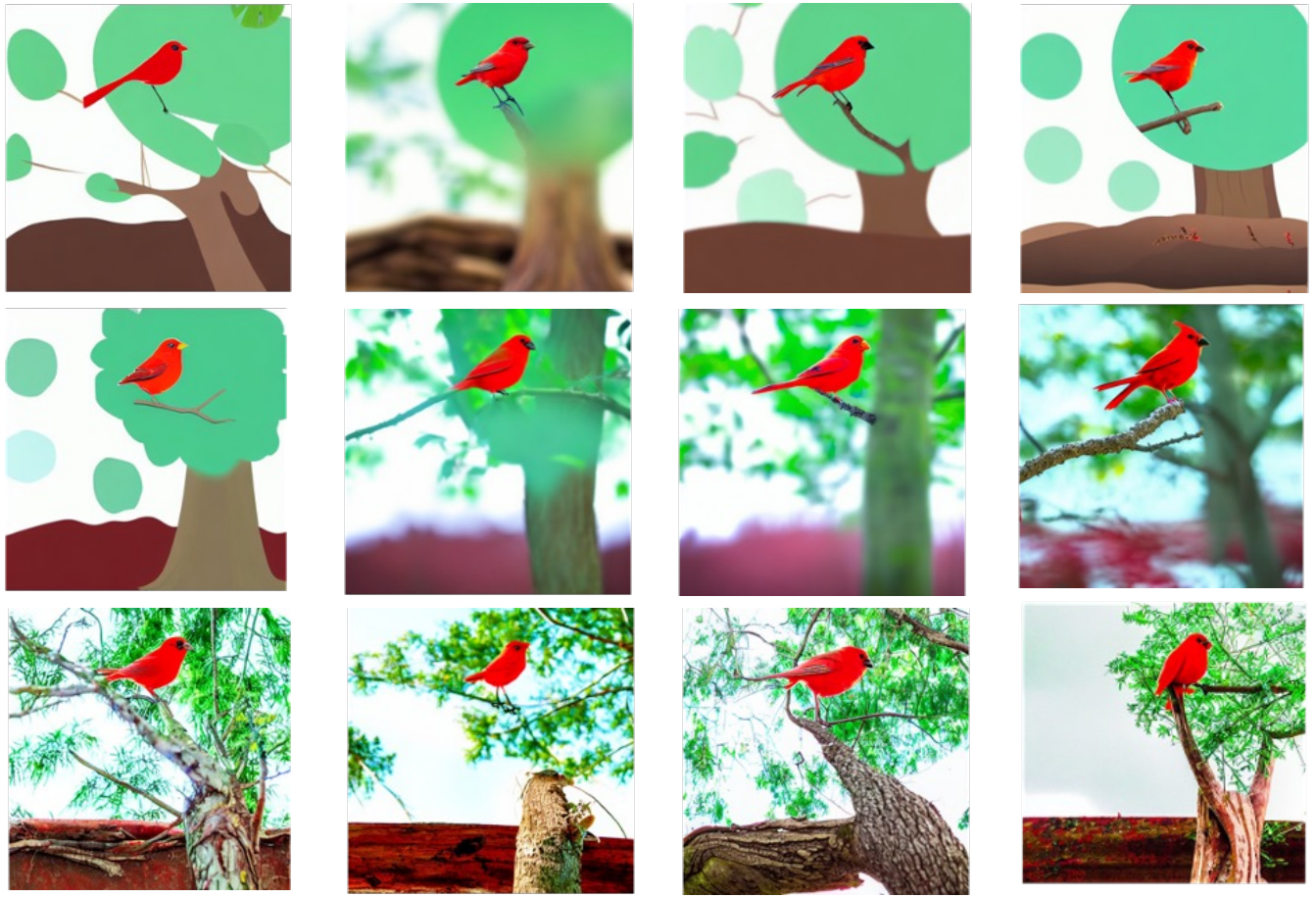


SDEdit

Iterative Loopback

GradOP (Ours)

Text Prompt: "a photo of a blue elephant in a field"

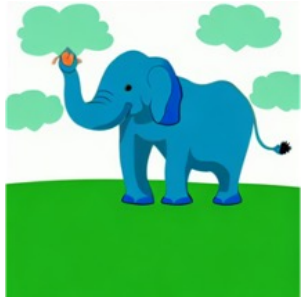



Target Subspace

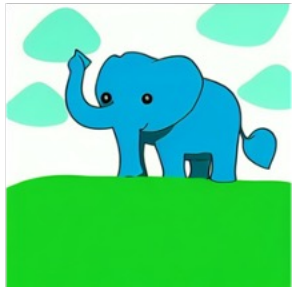
Text Prompt:
"a photo of a blue elephant in a field"

Reference Painting



SDEdit

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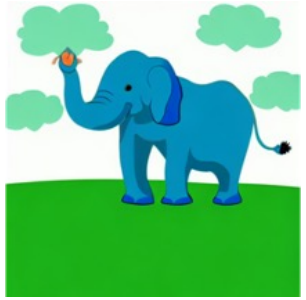

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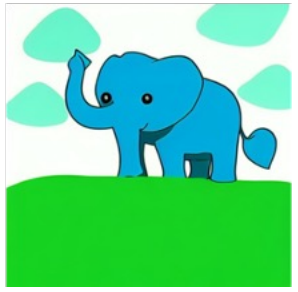


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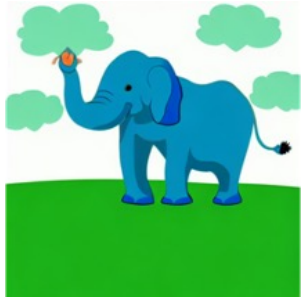

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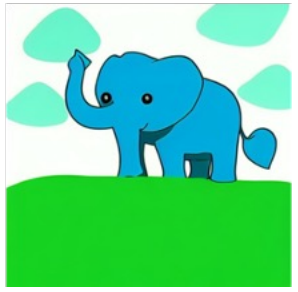
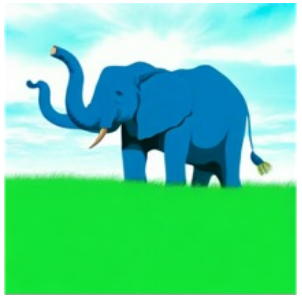
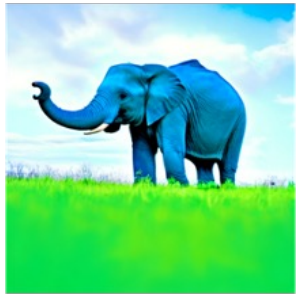


Iterative Loopback




GradOP (Ours)

Text Prompt: "a photo of castle by the lake"

Target Subspace

$t_0 = 0.7$ $t_0 = 0.75$ $t_0 = 0.8$ $t_0 = 0.85$ $t_0 = 0.9$ $t_0 = 0.95$ $t_0 = 0.99$

Reference Painting

SDEdit

Ours

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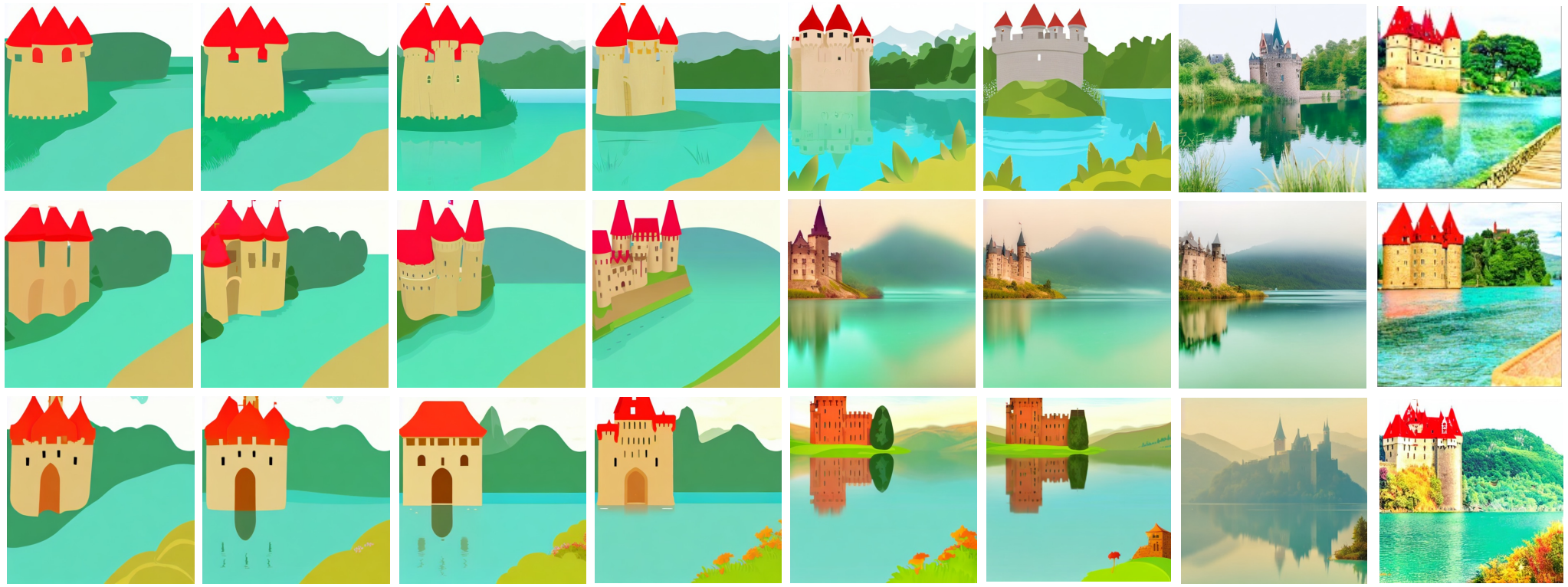
Reference Painting



SDEdit

Ours

Faithful but unrealistic

Text Prompt: "a photo of castle by the lake"

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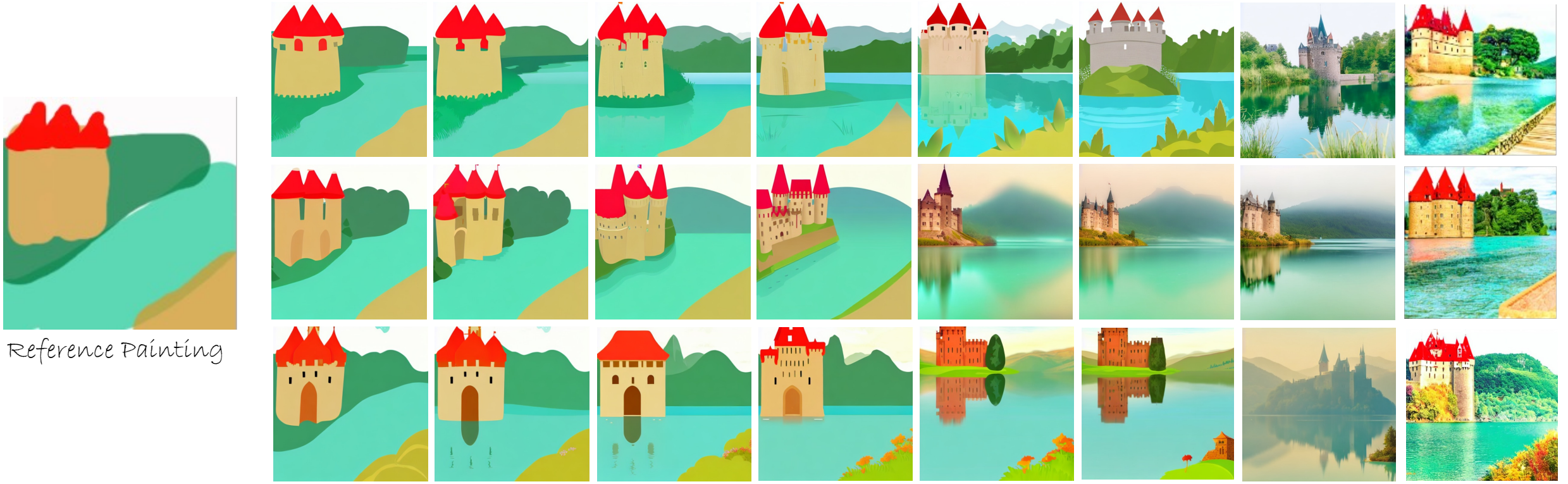

Reference Painting

SDEdit

Ours

Faithful but unrealistic

Realistic but unfaithful

Text Prompt: "a photo of castle by the lake"

Target Subspace

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Reference Painting

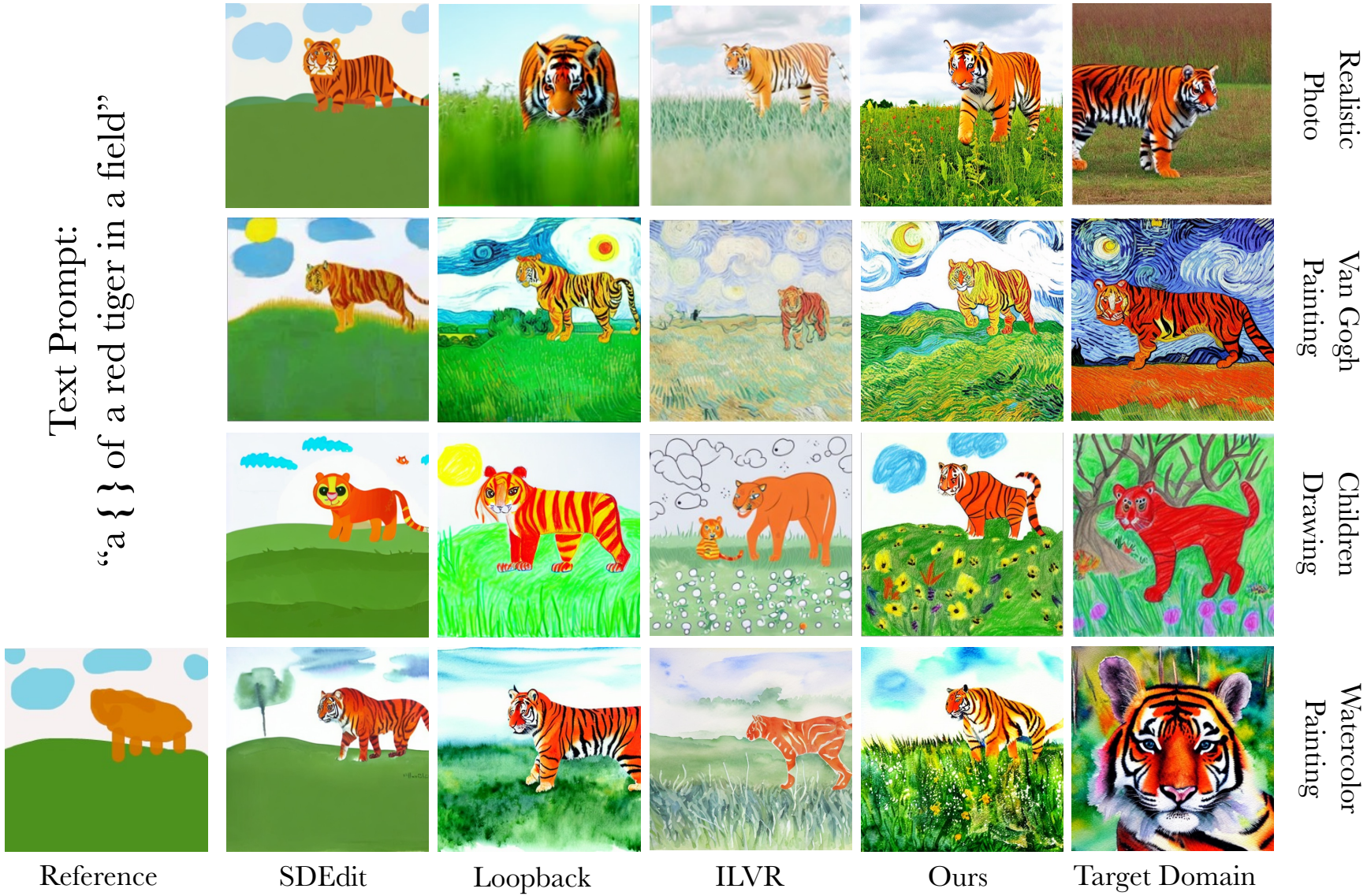
SDEdit

Faithful but unrealistic

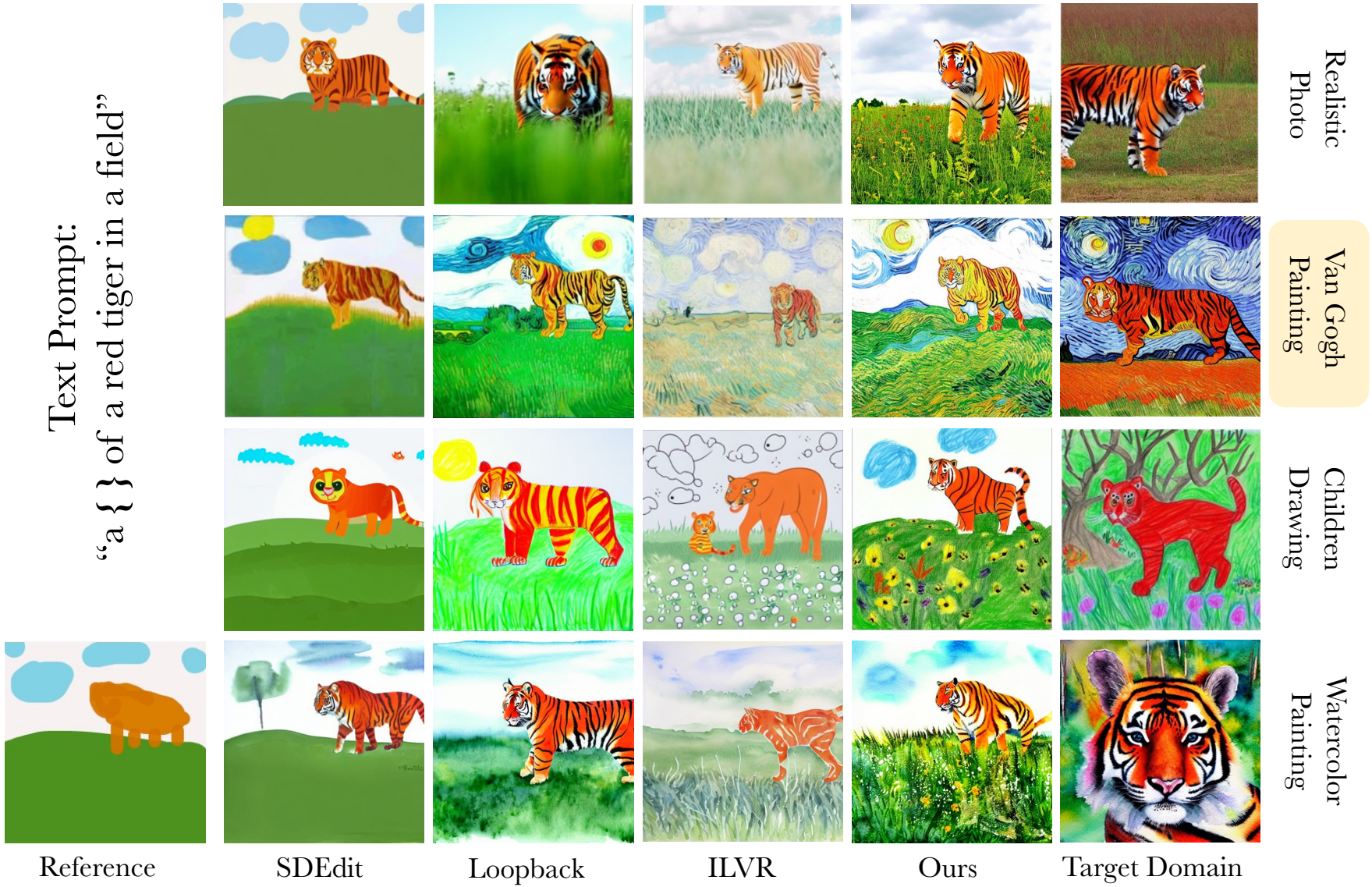
Realistic but unfaithful

Ours

Generalizability across Target Domains



Generalizability across Target Domains



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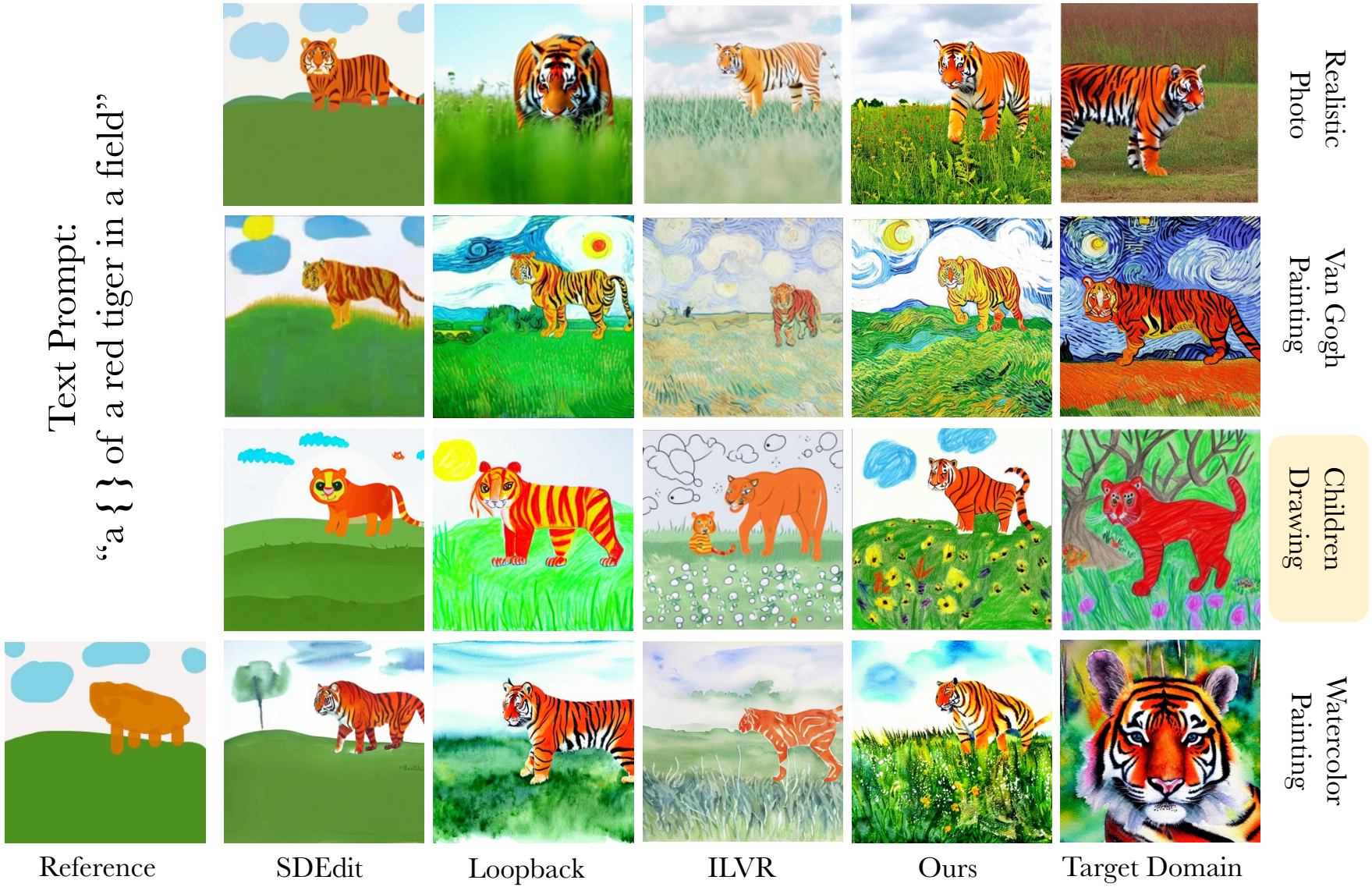
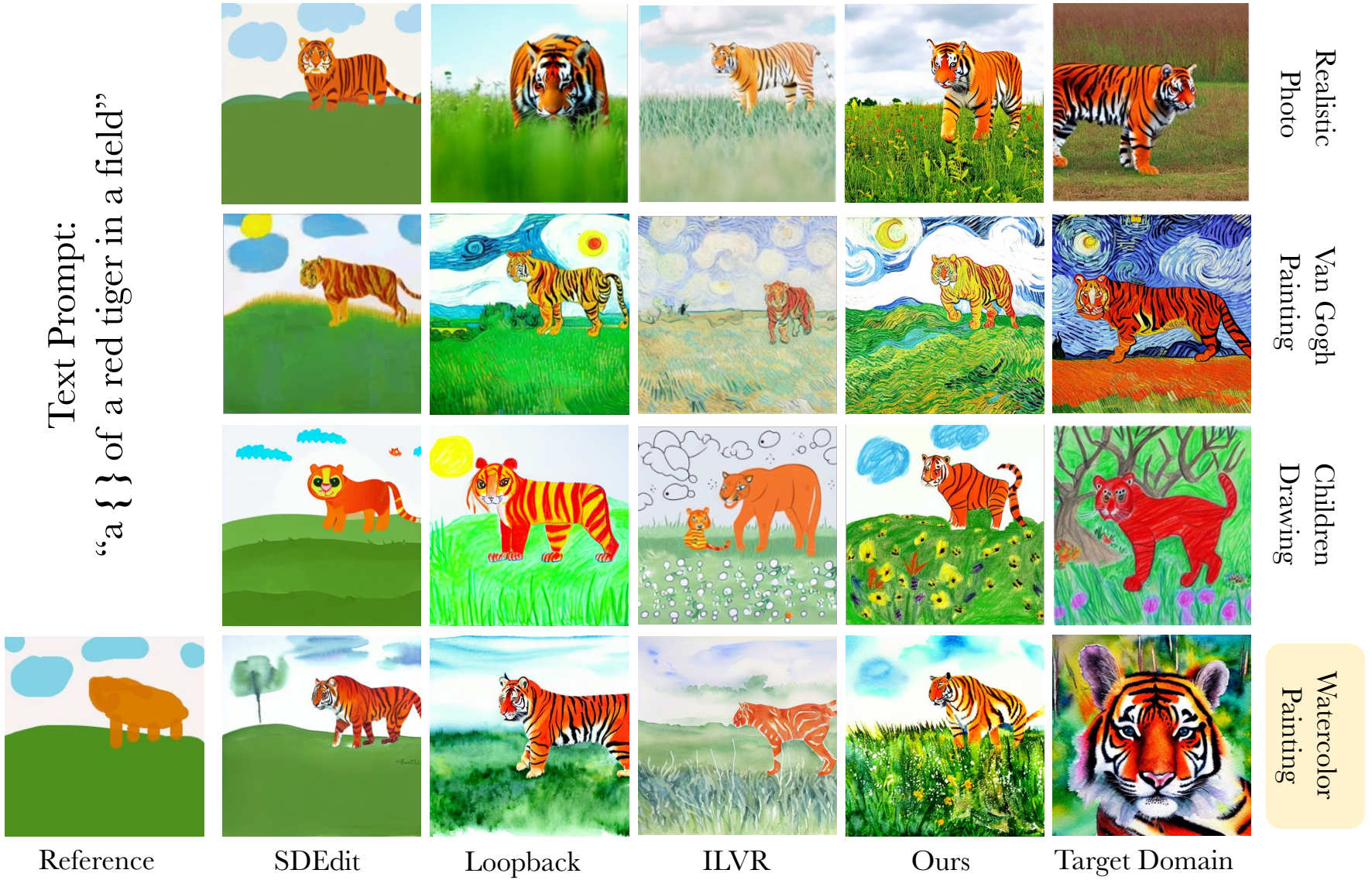


Generalizability across Target Domains



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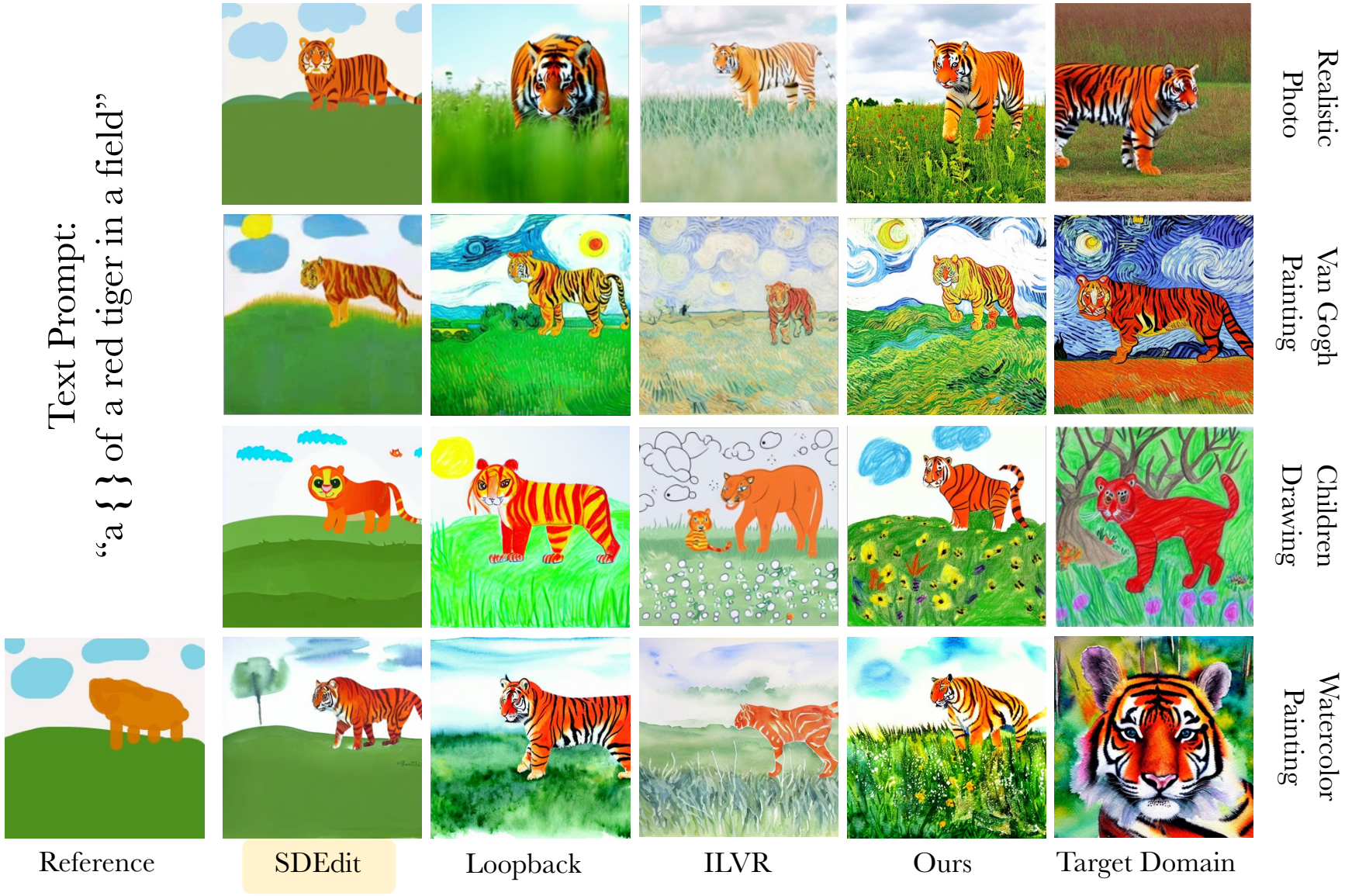

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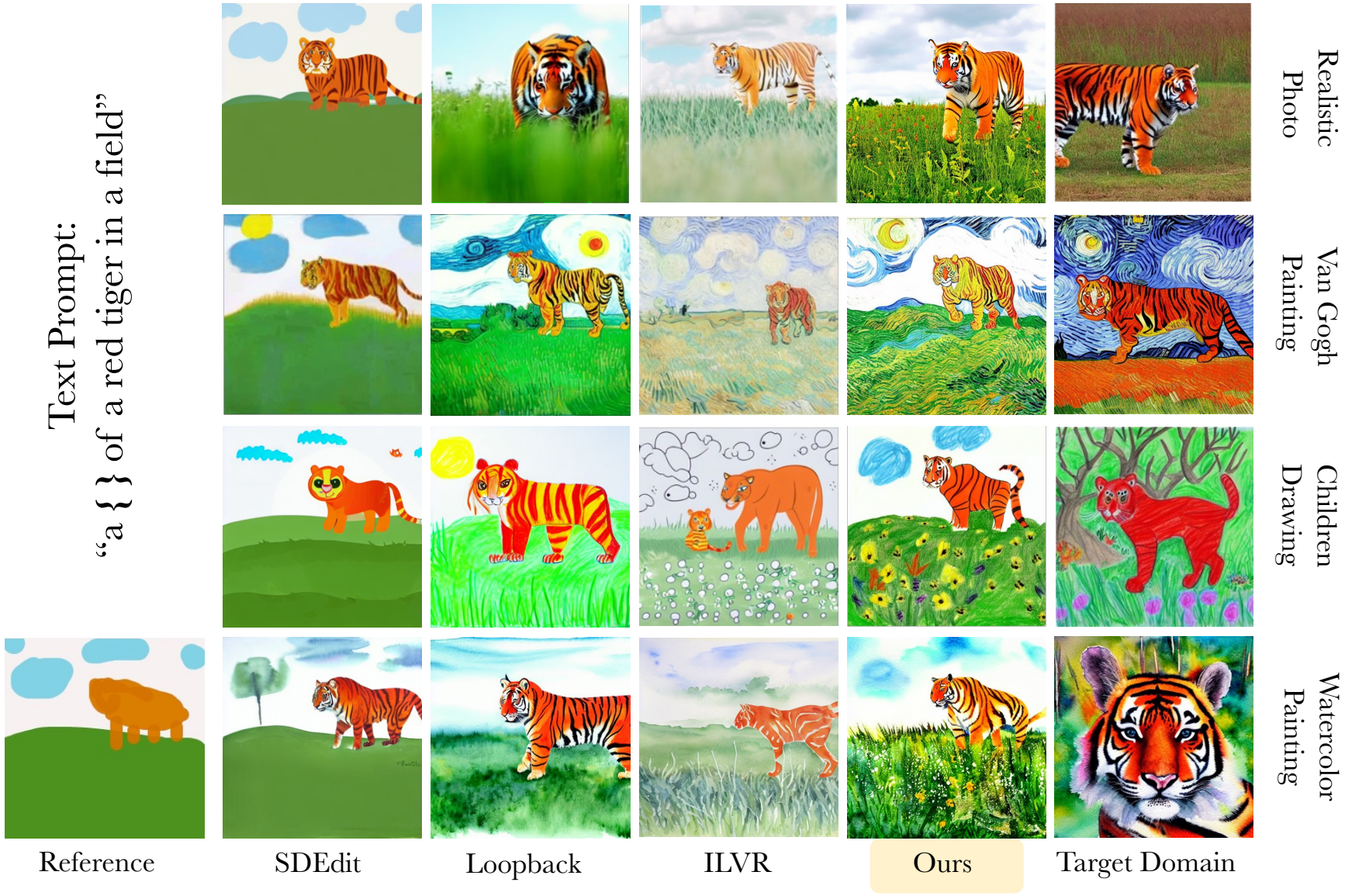

Controlling Semantics of Different Painting Regions

Text Prompt:

"a fantasy landscape, trending on artstation"

Reference Painting

Semantics of different painting regions might not accurately reflect user's intent.

Controlling Semantics of Different Painting Regions

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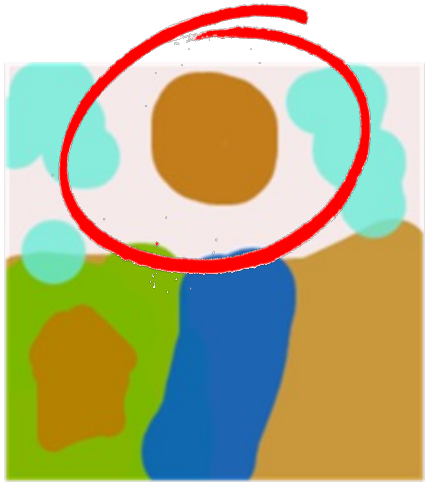

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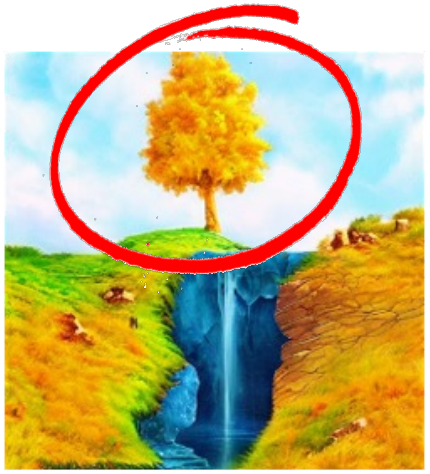


Semantics of different painting regions might not accurately reflect user's intent.

Controlling Semantics of Different Painting Regions

Text Prompt:

"a fantasy landscape, trending on artstation"

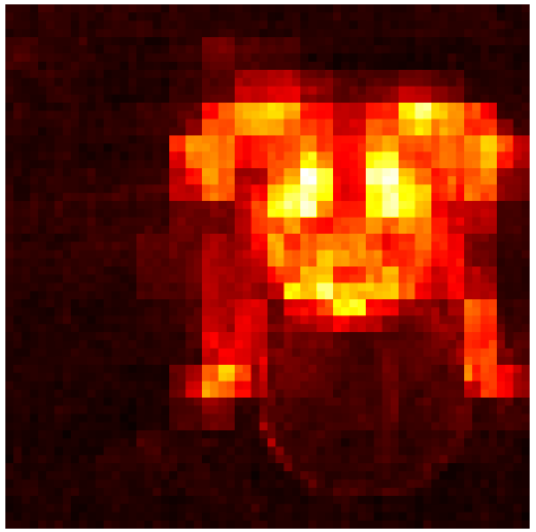
Reference Painting

Some regions might be entirely omitted if the model does not understand that it corresponds to a separate semantic entity

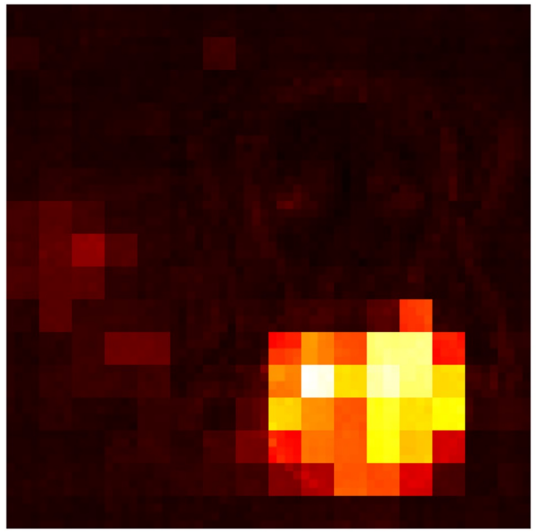
Controlling Semantics of Different Painting Regions

Text Prompt:
"a dog with a ball"

"dog"



"ball"



Average cross-attention maps during reverse diffusion process

Cross-Attention maps show high overlap with semantic segmentation of different entities

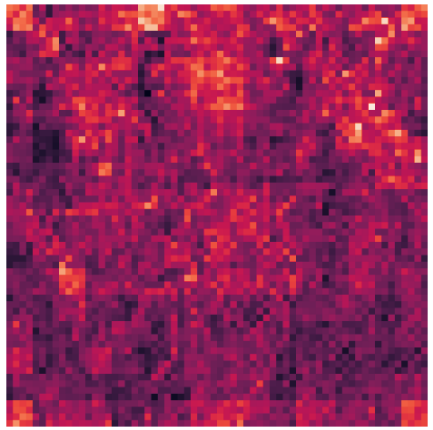
Reference Painting

Binary Mask for
Painting Region

Original
Cross-attention Map

Reference Painting

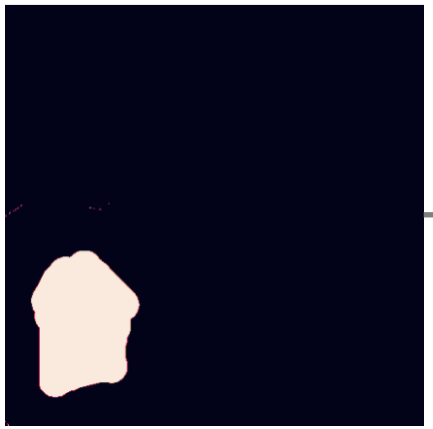
$\mathcal{B}_i$: “hut”



$\mathcal{A}_i^t$

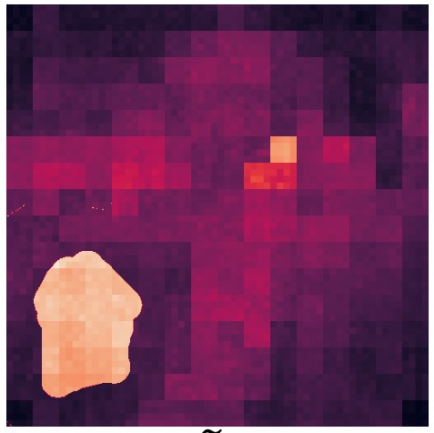
Reference Painting

Binary Mask for Painting Region



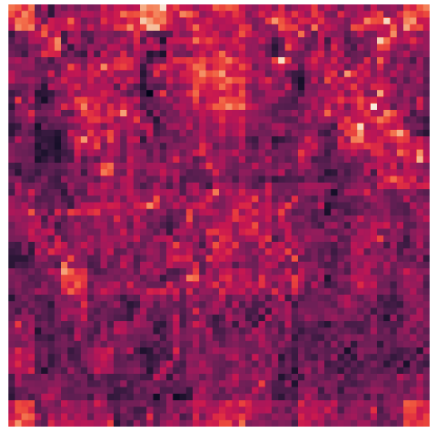
$\mathcal{B}_i$: "hut"

Modified Cross-attention Map



$\tilde{\mathcal{A}}_i^t$

Original Cross-attention Map



$\mathcal{A}_i^t$

Introducing Cross-attention Overlap with Desired Painting Regions

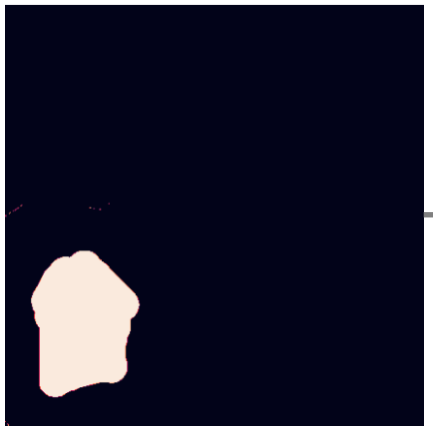
$$\tilde{\mathcal{A}}_t^i = w_i \left[(1 - \kappa_t)\, \mathcal{A}_t^i + \kappa_t \, \frac{\mathcal{B}_i}{\|\mathcal{B}_i\|_F} \, \|\mathcal{A}_t^i\|_F \right]$$

Binary Mask for Painting Region

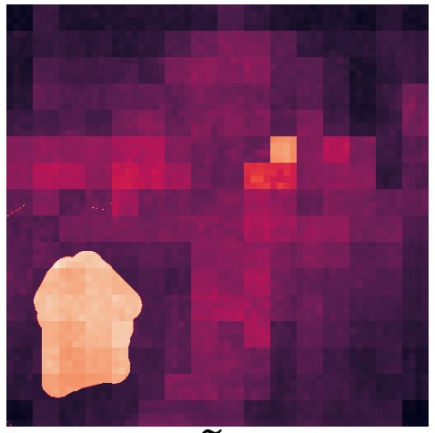
Modified Cross-attention Map

Original Cross-attention Map

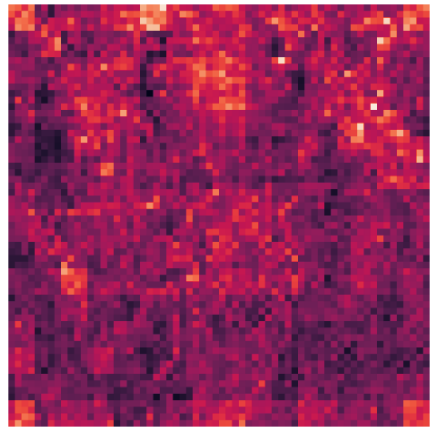
Reference Painting



$\mathcal{B}_i$: "hut"



$\tilde{\mathcal{A}}_i^t$



$\mathcal{A}_i^t$

Generated Image

Introducing Cross-attention Overlap with Desired Painting Regions

$$\tilde{\mathcal{A}}_t^i = w_i \left[(1 - \kappa_t)\, \mathcal{A}_t^i + \kappa_t \frac{\mathcal{B}_i}{\|\mathcal{B}_i\|_F} \|\mathcal{A}_t^i\|_F \right]$$

Reference Painting

Generation Outputs – w/o semantic control

Reference Painting

Generation Outputs – w/o semantic control

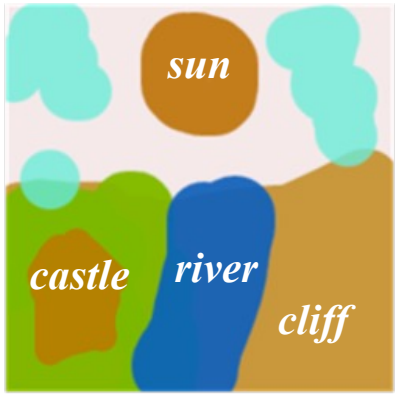
Semantic Guide

Generation Outputs – with semantic control

Reference Painting

Generation Outputs – w/o semantic control

Semantic Guide



Generation Outputs – with semantic control

JUNE 18-22, 2023
CVPR
VANCOUVER, CANADA

Thanks for listening!

Project Page and Online Demo
https://1jsingh.github.io/gradop

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Poster Tag: TUE-PM-179