ACE: ALL-ROUND CREATOR AND EDITOR Following Instructions via Diffusion Transformer

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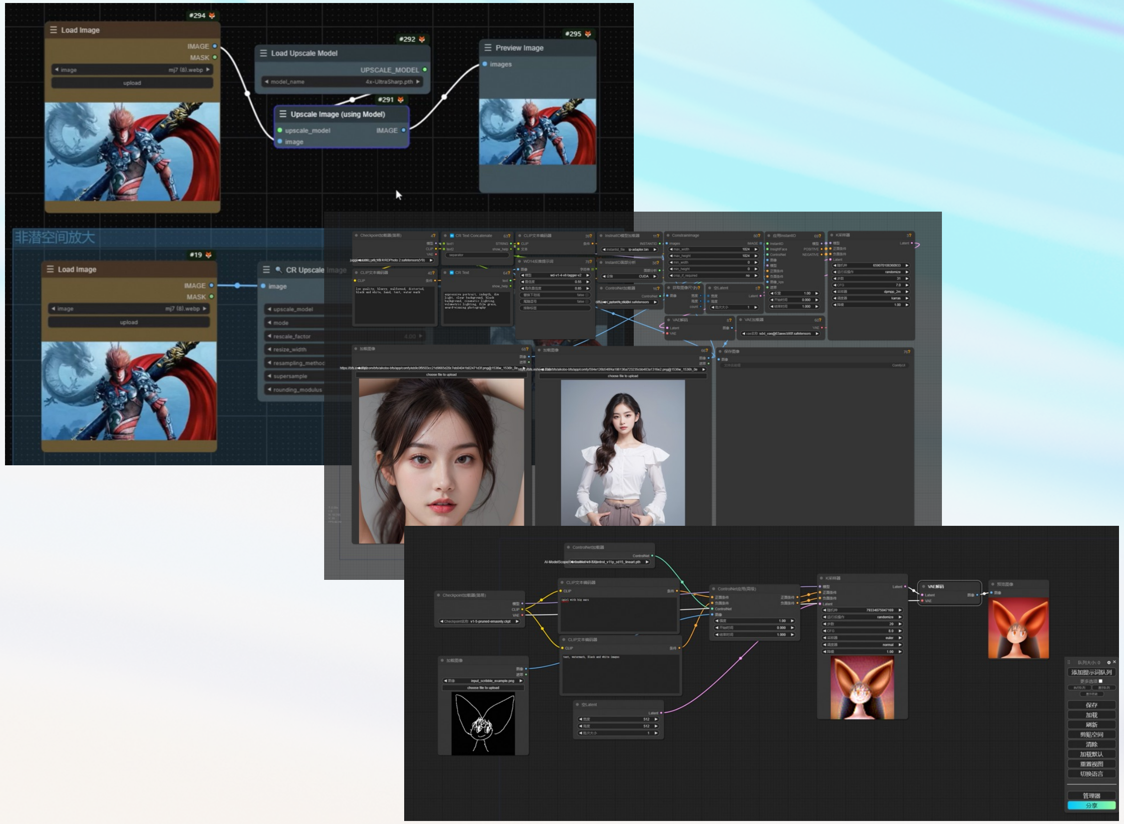
Contents

ACE: Making Editing as Simple as Generation

ACE provides a more convenient and versatile way of editing with instructions

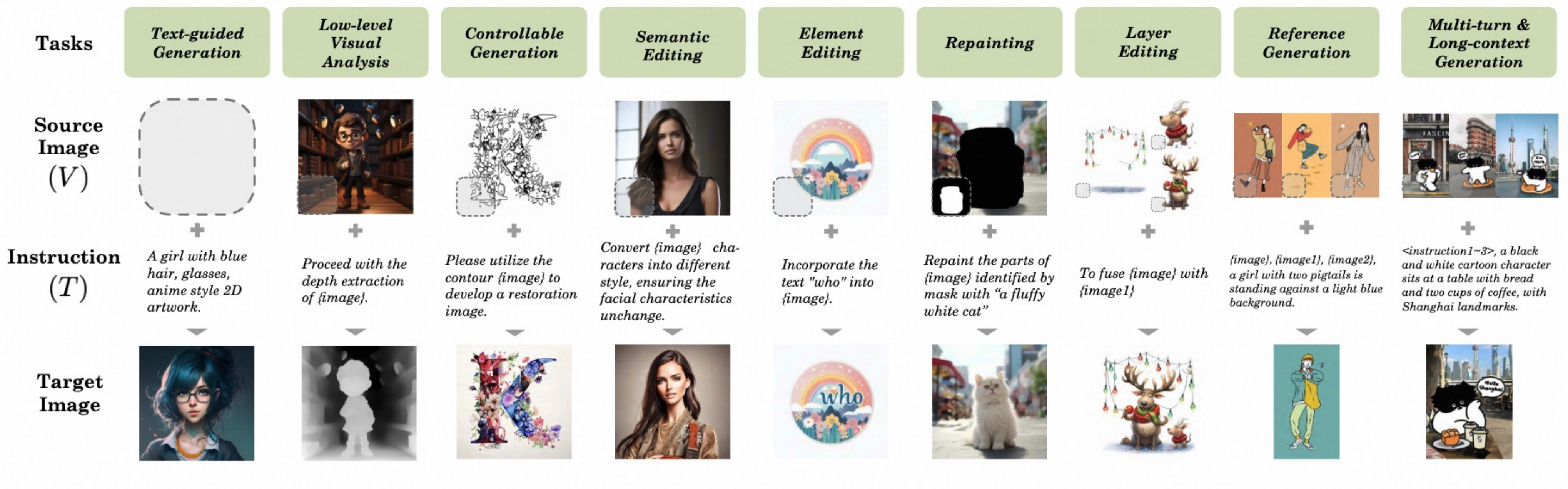


Editing With Comfyui workflows

Editing With ACE

ACE: Making Editing as Simple as Generation

- ✓ Visual generation and editing can be categorized into 9 types.
- ✓ The various tasks can be defined through a unified format.

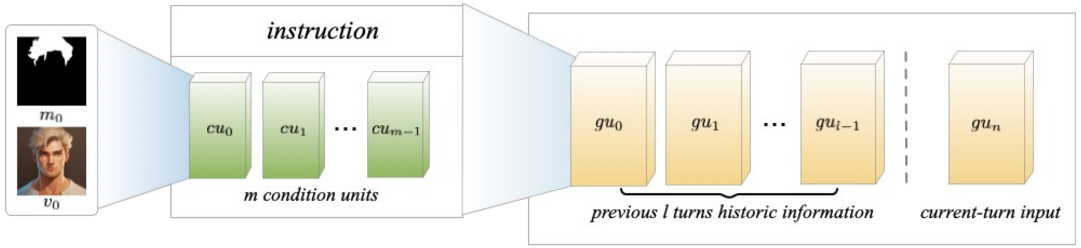


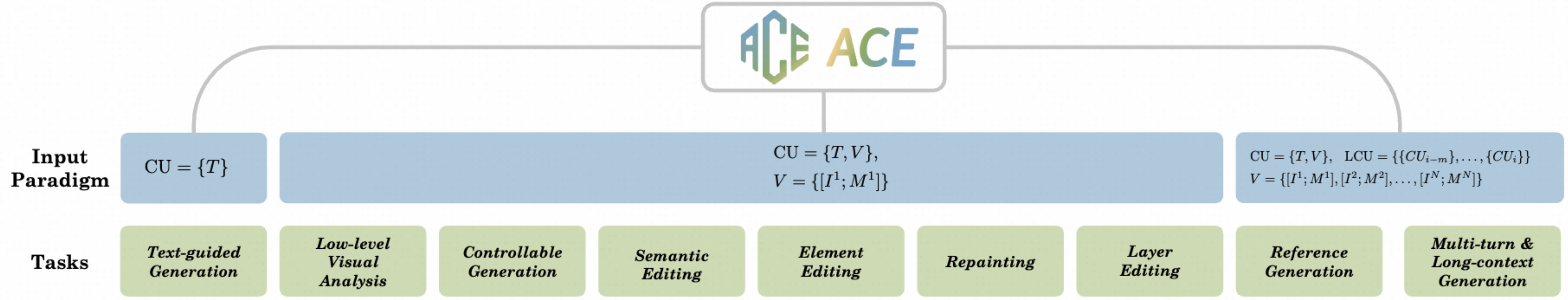
ACE: Making Editing as Simple as Generation

Unified Input Paradigm (LCU)

T: represents the instruction text,

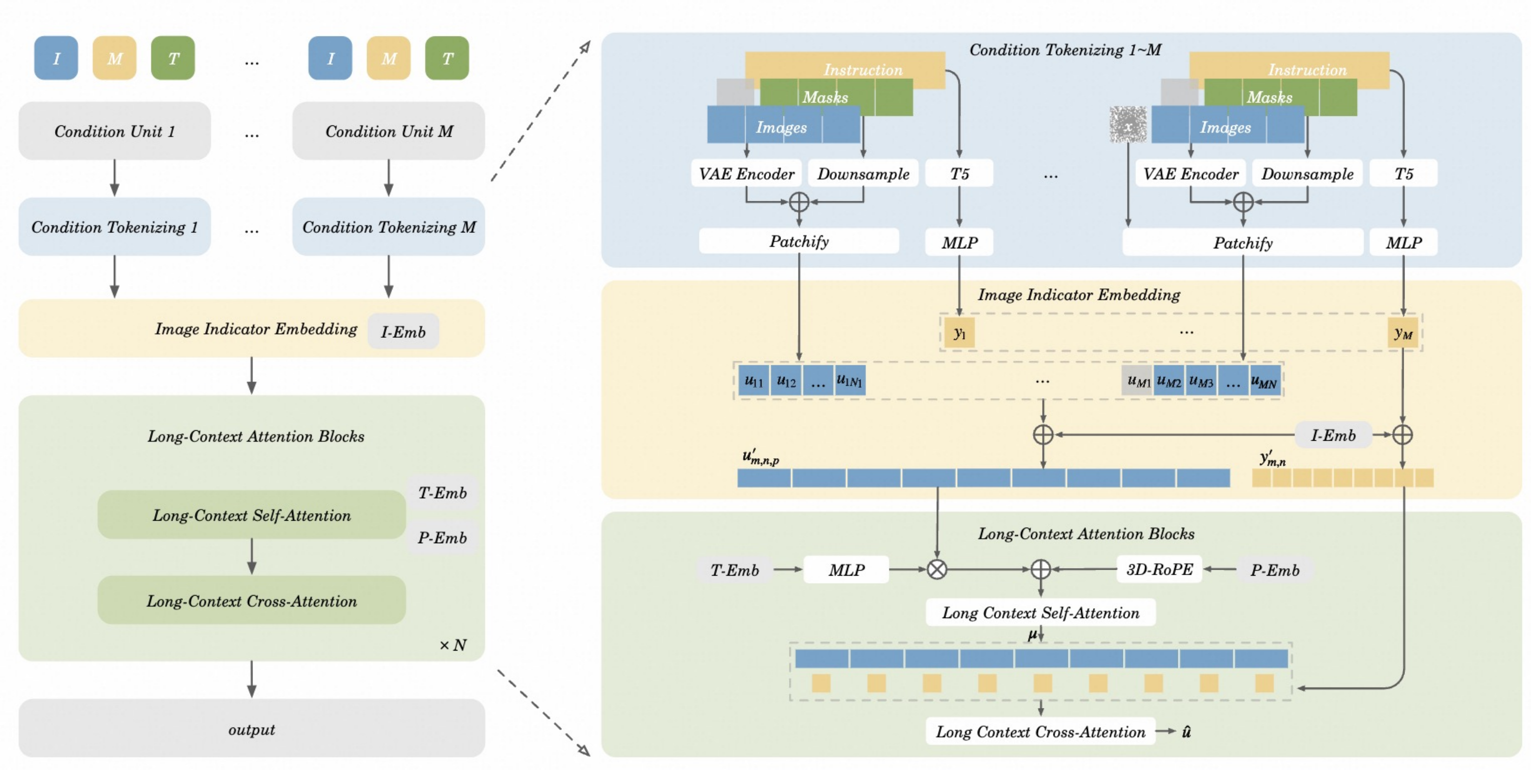
V: represents the visual condition unit, consisting of the image I and the mask M





Unified Multi-Task Generation / Editing Framework

✓ Multimodal Editing and Generation Framework Based on Dit(0.6B)



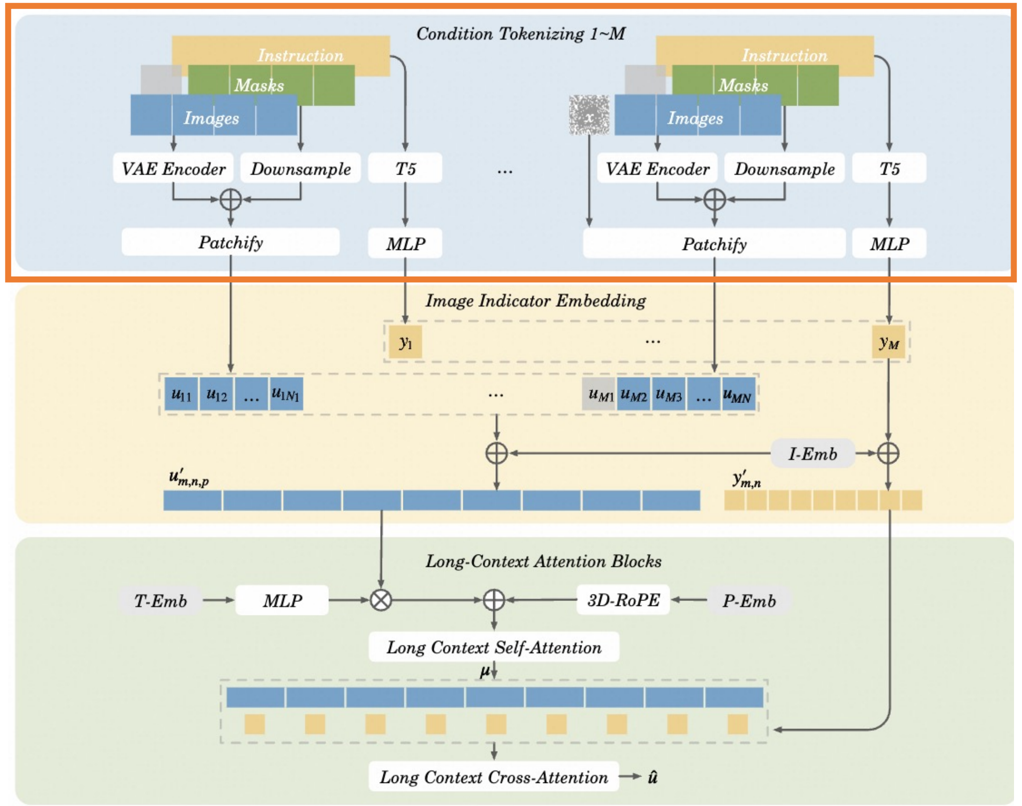
(a) Overall Architecture of ACE.

(b) Detailed Illustration of Main Blocks.

Unified Multi-Task Generation / Editing Framework

✓ **Multimodal Editing and Generation Framework Based on Dit**

Condition Tokenizing



Unified Multi-Task Generation / Editing Framework

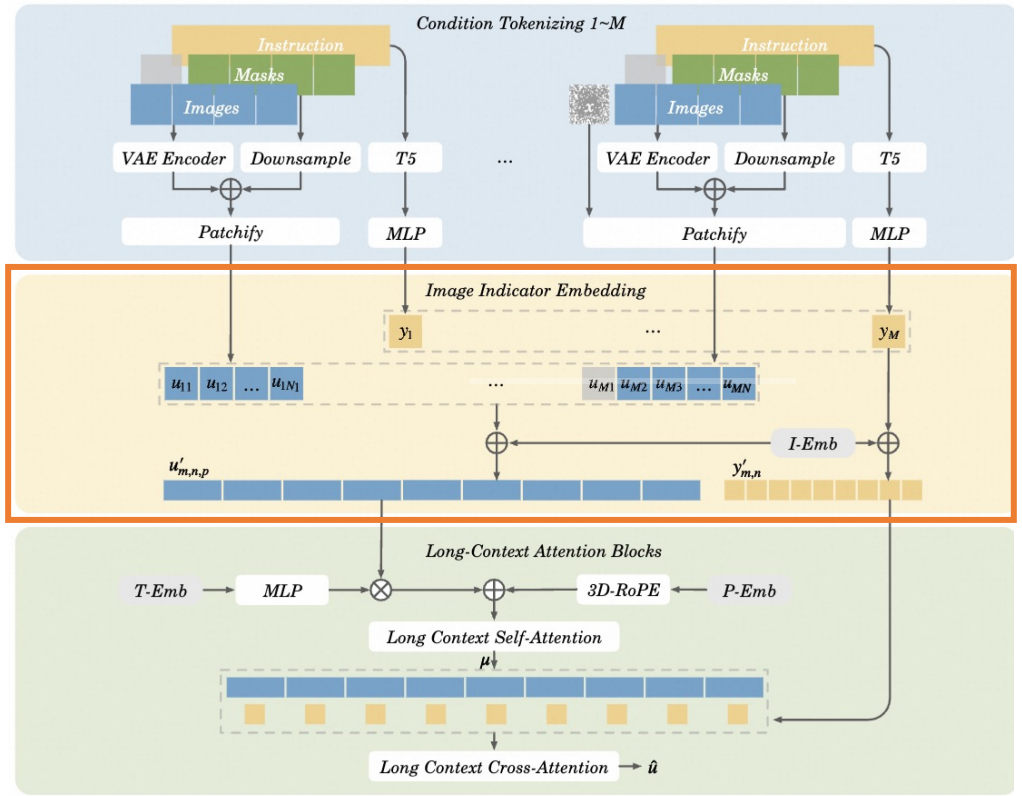
✓ Multimodal Editing and Generation Framework Based on Dit

Condition Tokenizing

$$y'_{m,n} = y_m + I\text{-Emb}_{m,n},$$

$$u'_{m,n,p} = u_{m,n,p} + I\text{-Emb}_{m,n}.$$

Image Indicator Embedding



Unified Multi-Task Generation / Editing Framework

✓ Multimodal Editing and Generation Framework Based on Dit

Condition Tokenizing

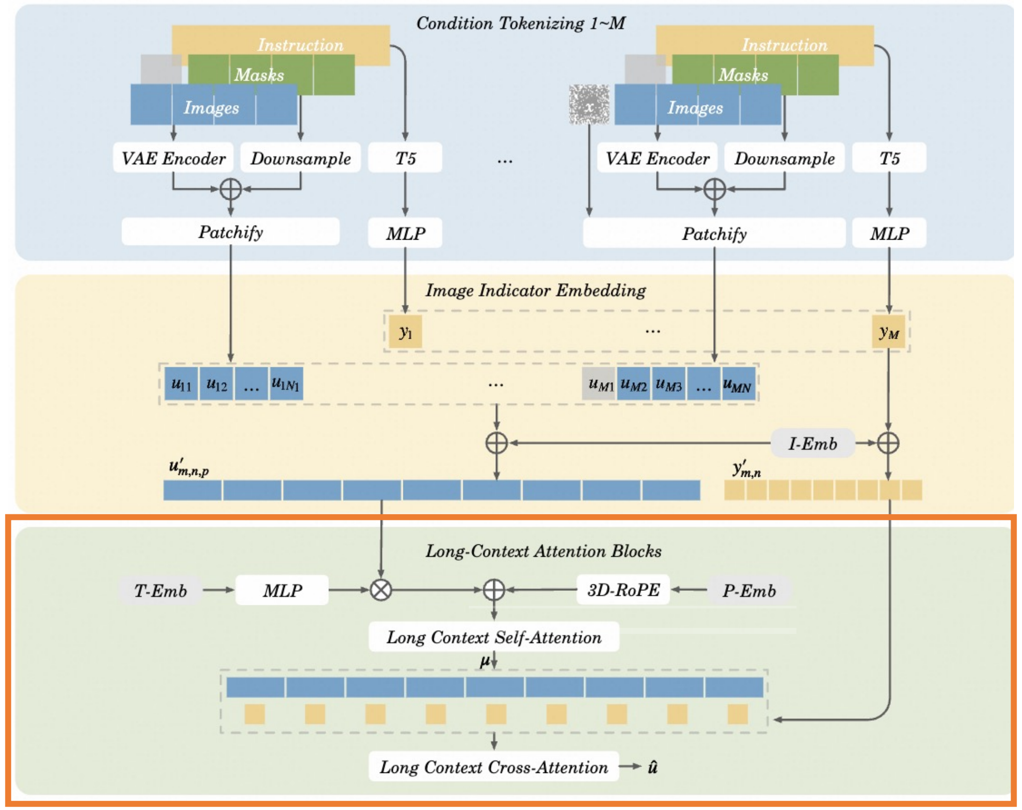
$$y'_{m,n} = y_m + I\text{-Emb}_{m,n},$$

$$u'_{m,n,p} = u_{m,n,p} + I\text{-Emb}_{m,n}.$$

Image Indicator Embedding

$$\hat{u}_{m,n} = Attn(\mu_{m,n}, y'_{m,n}).$$

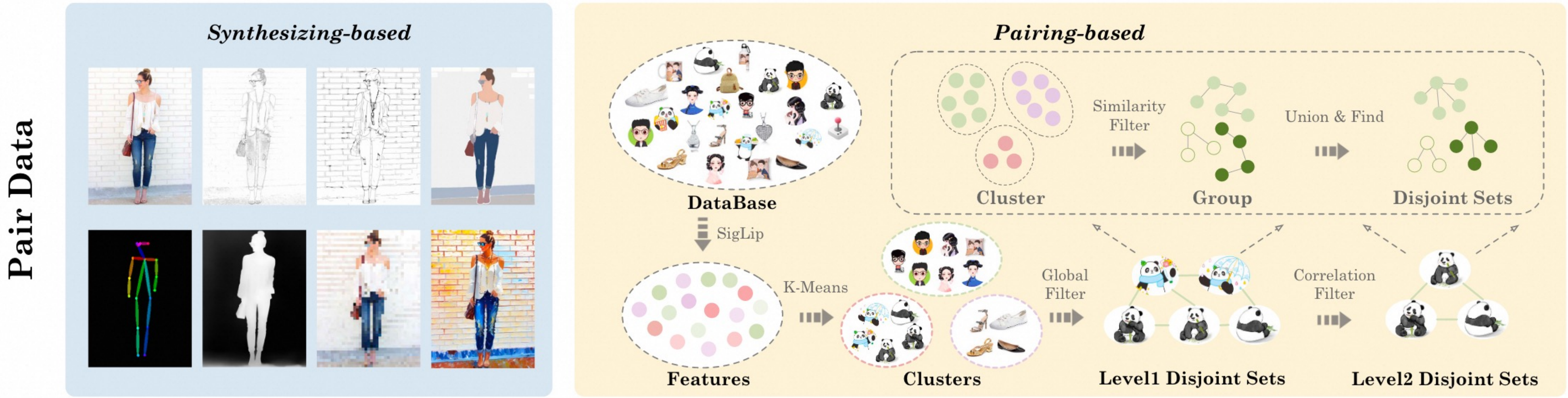
Long-Context Attention Blocks



Data Structuring and Quality Tuning

Scaling Data Construction and Annotation Process

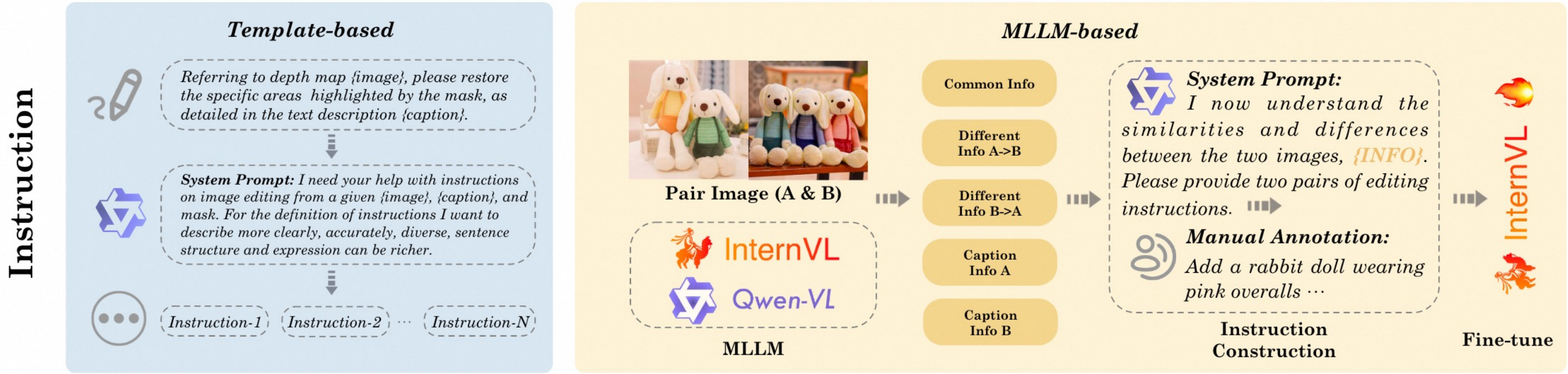
- ✓ Generate corresponding editing task data pairs based on existing generative models.
- ✓ Construct data pairs with similar attributes based on feature clustering, typically referencing image-related tasks.



Data Structuring and Quality Tuning

Instruction Labeling With Template-based and MLLM-based Methods

- ✓ Template-based method constructs instruction templates for specific vision tasks by leveraging human knowledge priors.
- ✓ The Instruction Captioner finetuned with curated instructions datasets to generate unique instructions for each given editing pair.

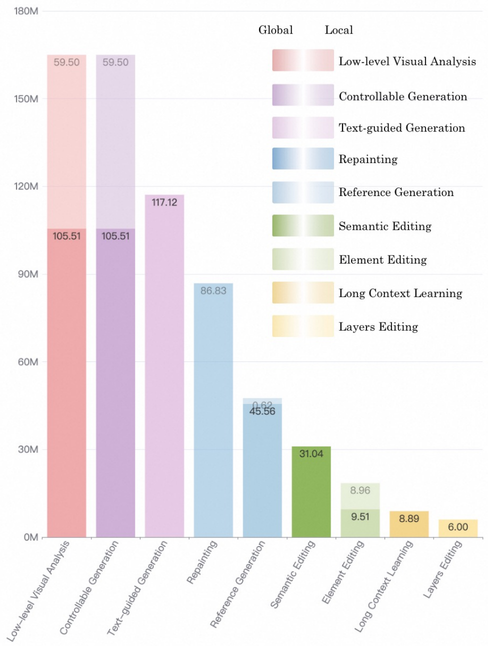


Data Structuring and Benchmark

ACE Dataset Distribution

✓ Covers 37 subtasks under 8 fundamental tasks.

a. The distribution of all tasks in the dataset



b. The data scale of basic tasks in the dataset

Data Structuring and Benchmark

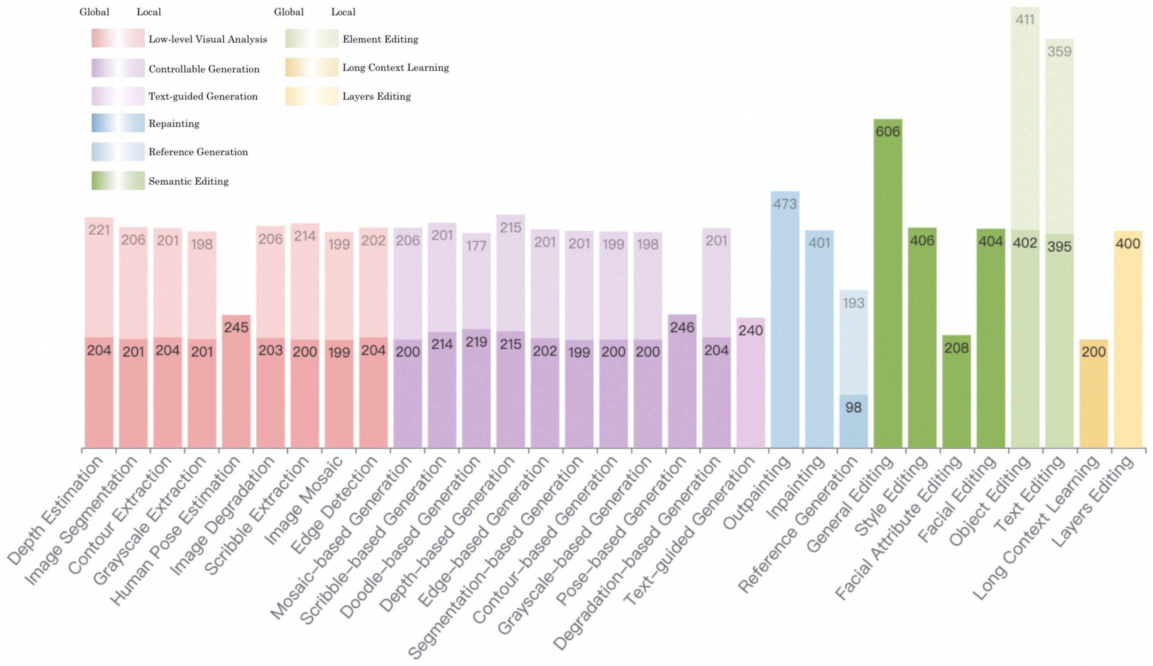
ACE Benchmark Distribution

(1) Total 12k: includes 6k real images an d 6k generated images。

(2) Evaluation for tasks such as local an d global editing, reference generation, multi-round editing, and composite gen eration.

(3) Total 31 subtasks: it is currently the l argest benchmark in the field with the most comprehensive coverage of tasks.

Benchmark	Real Image?	Generated Image?	Multi-turn?	Regional?	Tasks	Data Scale
MagicBrush	Y	N	Y	Y	-	1588
Emu Edit	Y	N	N	N	8	3589
ACE	Y	Y	Y	Y	31	12000



Model Performance and Applications

Quantitative Analysis

Settings	Methods	L1↓	L2↓	CLIP-I↑	DINO↑	CLIP-T↑
	Global Description-guided					
Single-turn	SD-SDEdit (Meng et al., 2021)	0.1014	0.0278	0.8526	0.7726	0.2777
	Null Text Inversion (Mokady et al., 2022)	0.0749	0.0197	0.8827	0.8206	0.2737
	GLIDE (Nichol et al., 2022)	3.4973	115.8347	**0.9487**	**0.9206**	0.2249
	Blended Diffusion (Avrahami et al., 2022)	3.5631	119.2813	0.9291	0.8644	0.2622
	ACE (Ours)	**0.0505**	**0.0160**	0.9436	0.9184	**0.2833**
	Instruction-guided					
	HIVE (Zhang et al., 2024)	0.1092	0.0380	0.8519	0.7500	-
	InstructPix2Pix (Brooks et al., 2023)	0.1122	0.0371	0.8524	0.7428	0.2764
	MagicBrush (Zhang et al., 2023a)	0.0625	0.0203	0.9332	0.8987	0.2781
	UltraEdit (Zhao et al., 2024)	0.0575	0.0172	0.9307	0.8982	-
	ACE (Ours)	**0.0507**	**0.0165**	**0.9453**	**0.9215**	**0.2841**
	Global Description-guided					
Multi-turn	SD-SDEdit (Meng et al., 2021)	0.1616	0.0602	0.7933	0.6212	0.2694
	Null Text Inversion (Mokady et al., 2022)	0.1057	0.0335	0.8468	0.7529	0.2710
	GLIDE (Nichol et al., 2022)	11.7487	1079.5997	0.9094	0.8494	0.2252
	Blended Diffusion (Avrahami et al., 2022)	14.5439	1510.2271	0.8782	0.7690	0.2619
	ACE (Ours)	0.0778	0.0290	0.9124	0.8611	**0.2843**
	ACE (Ours w/ LC)	**0.0768**	**0.0285**	**0.9136**	**0.8635**	0.2819
	Instruction-guided					
	HIVE (Zhang et al., 2024)	0.1521	0.0557	0.8004	0.6463	0.2673
	InstructPix2Pix (Brooks et al., 2023)	0.1584	0.0598	0.7924	0.6177	0.2726
	MagicBrush (Zhang et al., 2023a)	0.0964	0.0353	0.8924	0.8273	0.2754
	UltraEdit (Zhao et al., 2024)	**0.0745**	**0.0236**	0.9045	0.8505	-
	ACE (Ours)	0.0773	0.0293	0.9128	0.8661	**0.2855**
	ACE (Ours w/ LC)	0.0761	0.0284	**0.9140**	**0.8668**	0.2809

Comparison on the MagicBrush Benchmark

Method	CLIPdir↑	CLIPout↑	L1↓	CLIPimg↑	DINO↑
InstructPix2Pix (Brooks et al., 2023)	0.0739	0.2681	0.1240	0.8508	0.7647
MagicBrush (Zhang et al., 2023a)	0.0831	0.2701	0.0995	0.8664	0.7927
Emu Edit (Sheynin et al., 2024)	**0.1073**	**0.2791**	0.0893	0.8743	0.8398
UltraEdit (Zhao et al., 2024)	0.0888	0.2783	**0.0532**	0.8814	0.8524
CosXL (StabilityAI, 2024)	0.0901	0.2775	0.0940	0.8686	0.8340
ACE (Ours)	0.0855	0.2746	0.0761	**0.8952**	**0.8620**

Comparison on the EmuEdit Benchmark

Method	Face Similarity	Effective Score
InstantID† Wang et al. (2024b)	84.08	0.96
CosXL StabilityAI (2024)	66.49	0.37
UltraEdit Zhao et al. (2024)	62.91	0.16
IP-Adapter Ye et al. (2023)	66.51	0.31
FaceChain Liu et al. (2023b)	65.46	0.42
ACE (Ours)	**70.07**	**0.67**

Quantitative Evaluation of Portrait Preservation

Method	Edit Distance	Sentence Accuracy
UDiffText (Zhao & Lian, 2024)	0.6827	0.4110
AnyText (Tuo et al., 2023)	0.6035	0.3313
ACE (Ours)	**0.8211**	**0.5767**

Quantitative Evaluation of Text Editing

Model Performance and Applications

Human Study

(1) Results generated by different methods are ranked manually.

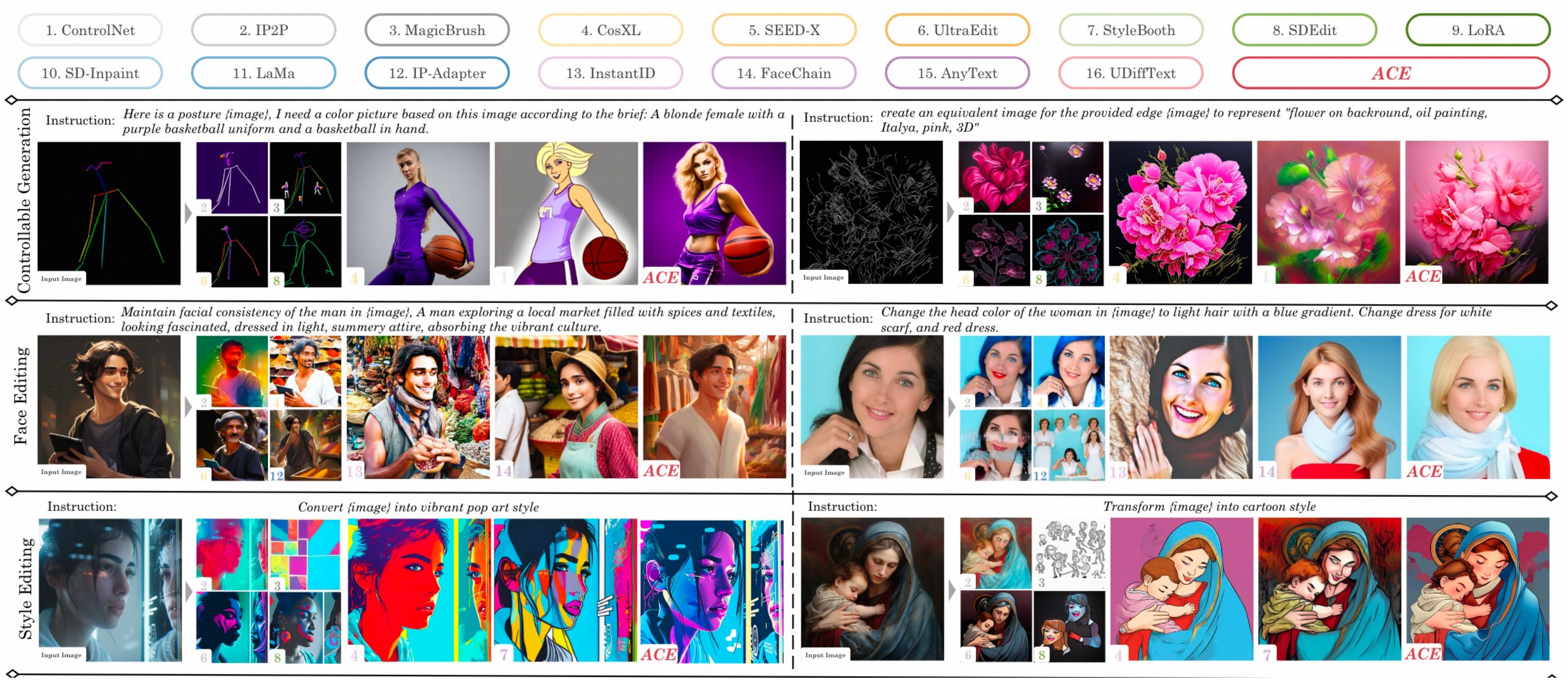
(2) Five designers serve as annotators, ensuring that each sample is evaluated by at least three individuals.

(3) Among the 21 benchmarkable tasks, a win rate of 15 out of 21 has been achieved.

	Txt2img	Controllable				Semantic			Element				Repainting	
	Txt2img	Canny	Depth	Scribble	Pose	Face	Style	General	Add Text	Rm Text	Add Obj.	Rm Obj.	Inpaint	Outpaint
Global Editing														
SD1.5 (AI, 2022a)	3.3/2.2	-	-	-	-	-	-	-	-	-	-	-	-	-
SDXL (StabilityAI, 2022)	**4.1/2.8**	-	-	-	-	-	-	-	-	-	-	-	-	-
CtrlNet (Zhang et al., 2023b)	-	2.5/2.0	3.8/2.4	1.9/2.0	2.9/1.9	-	-	-	-	-	-	-	-	-
StyleBooth (Han et al., 2024)	-	-	-	-	-	-	**3.3**/2.6	-	-	-	-	-	-	-
IP-Adapter (Ye et al., 2023)	-	-	-	-	-	2.0/2.2	-	1.7/2.5	-	-	-	-	-	-
InstantID (Wang et al., 2024b)	-	-	-	-	-	2.5/2.7	-	-	-	-	-	-	-	-
FaceChain (Liu et al., 2023b)	-	-	-	-	-	2.0/3.0	-	-	-	-	-	-	-	-
SDEdit (Meng et al., 2021)	-	1.4/1.9	1.3/1.8	1.1/1.6	1.2/1.4	1.3/2.1	1.1/1.7	1.5/2.1	1.1/2.2	1.1/1.7	1.5/2.1	1.1/2.0	-	-
IP2P (Brooks et al., 2023)	-	1.9/2.0	1.7/2.0	1.5/2.3	1.4/1.4	2.3/2.4	2.4/2.5	2.2/2.4	1.1/2.6	1.3/2.6	2.0/2.4	1.5/2.4	-	-
MB (Zhang et al., 2023a)	-	1.3/1.8	1.3/1.7	1.3/1.9	1.1/1.3	2.4/2.3	1.4/2.0	2.2/2.3	1.5/2.4	2.2/2.5	**3.1**/2.2	2.1/2.4	-	-
SEED-X (Ge et al., 2024b)	-	1.6/2.1	1.7/2.0	1.7/2.2	1.5/1.5	2.0/2.7	2.2/2.5	2.1/2.7	1.3/2.6	2.1/2.6	1.9/**2.6**	2.5/2.4	-	-
CosXL (StabilityAI, 2024)	-	4.1/**2.9**	4.1/**2.8**	2.6/**2.9**	3.7/2.1	**2.9/3.1**	3.2/**3.0**	**3.2/2.9**	1.4/**2.7**	1.0/**2.9**	2.8/2.5	1.1/**3.1**	-	-
UltraEdit (Zhao et al., 2024)	-	1.7/2.2	1.2/1.8	1.3/2.3	1.1/1.3	2.3/2.5	2.1/2.4	2.6/2.5	1.7/2.6	1.1/2.7	2.7/2.3	1.5/2.6	-	-
ACE (Ours)	3.7/2.5	**4.6**/2.7	**4.5/2.8**	**4.8/2.9**	**4.1/2.3**	2.8/2.8	2.4/2.6	2.1/2.5	**2.8/2.7**	**4.4/2.9**	2.6/2.4	**3.9**/2.5	-	-
Local Editing														
LaMa (Suvorov et al., 2022)	-	-	-	-	-	-	-	-	-	3.6/2.8	-	**4.5/2.8**	1.6/2.3	3.0/2.4
SDInpaint (AI, 2022b)	-	-	-	-	-	-	-	-	-	2.6/2.6	1.6/**2.7**	2.2/2.5	3.6/2.6	-
CtrlNet (Zhang et al., 2023b)	-	-	-	-	-	-	-	-	-	2.9/2.7	1.9/2.5	2.6/2.2	3.0/2.1	3.2/2.1
AnyText (Tuo et al., 2023)	-	-	-	-	-	-	-	-	3.5/2.7	-	-	-	-	-
UDiffText (Zhao & Lian, 2024)	-	-	-	-	-	-	-	-	3.6/2.7	-	-	-	-	-
UltraEdit (Zhao et al., 2024)	-	1.4/1.9	1.2/1.8	1.2/2.0	-	-	-	-	1.1/2.8	1.2/**2.9**	2.9/2.5	1.4/2.5	1.1/1.7	1.1/2.1
ACE (Ours)	-	**4.8/2.6**	**4.3/2.5**	**4.8/2.6**	-	-	-	-	**4.5/2.9**	**4.5/2.9**	**3.7**/2.5	4.3/2.5	**4.4/2.7**	**4.6/2.8**

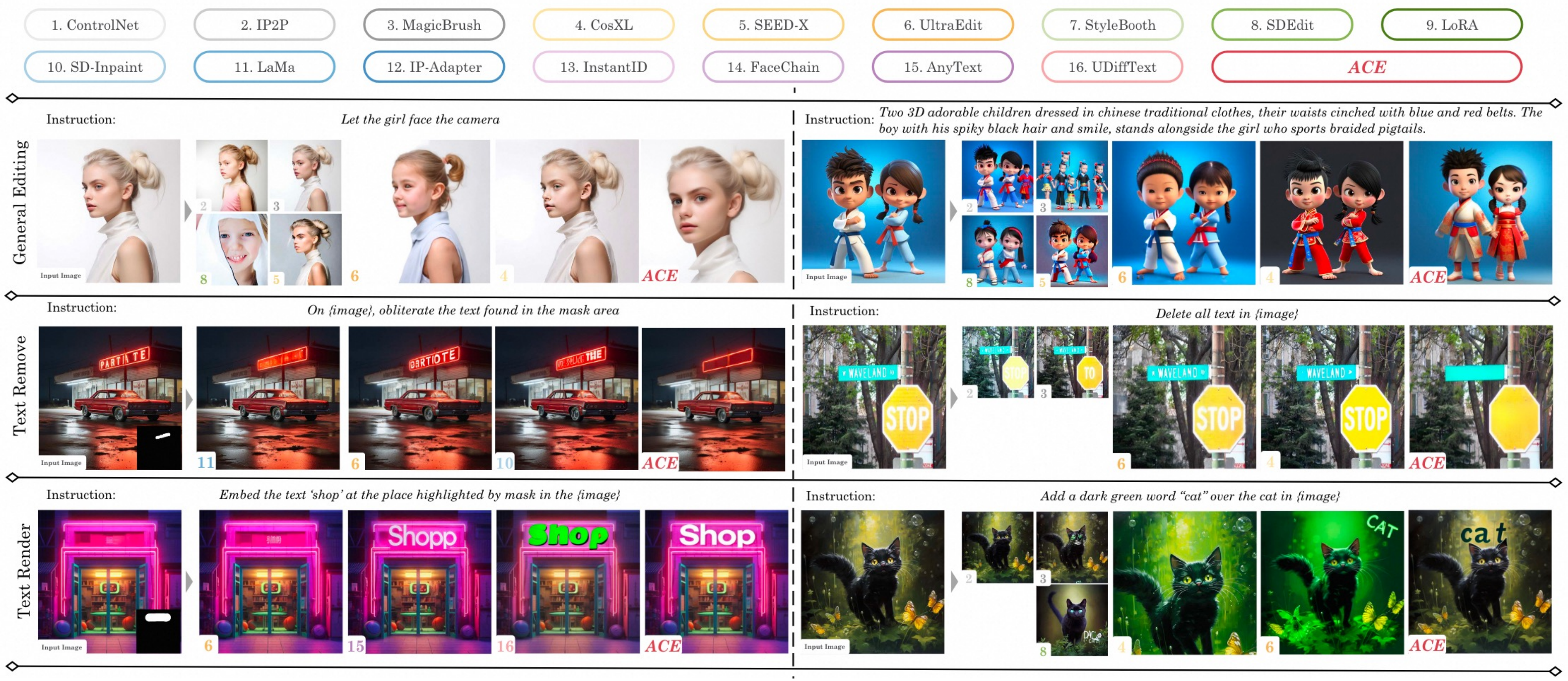
Model Performance and Applications

Visual Comparison



Model Performance and Applications

Visual Comparison



Model Performance and Applications

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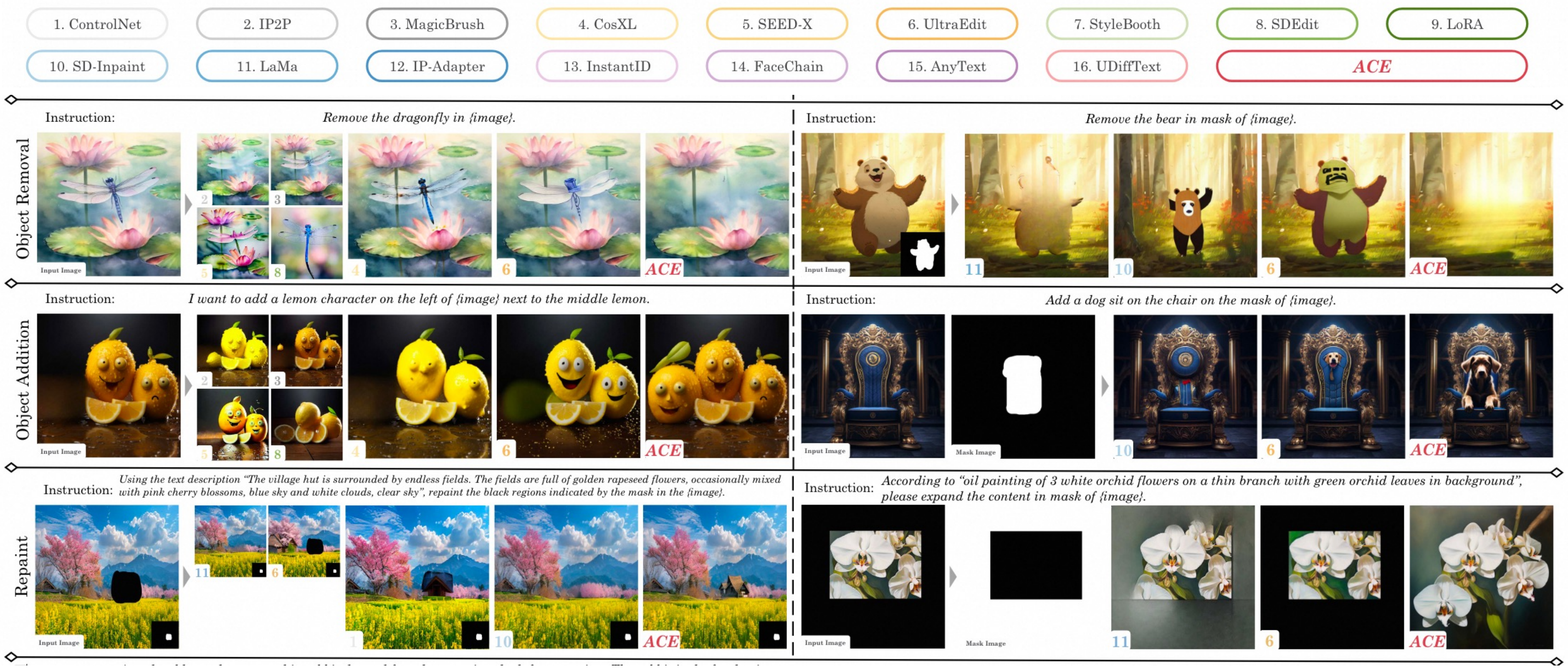

Model Performance and Applications

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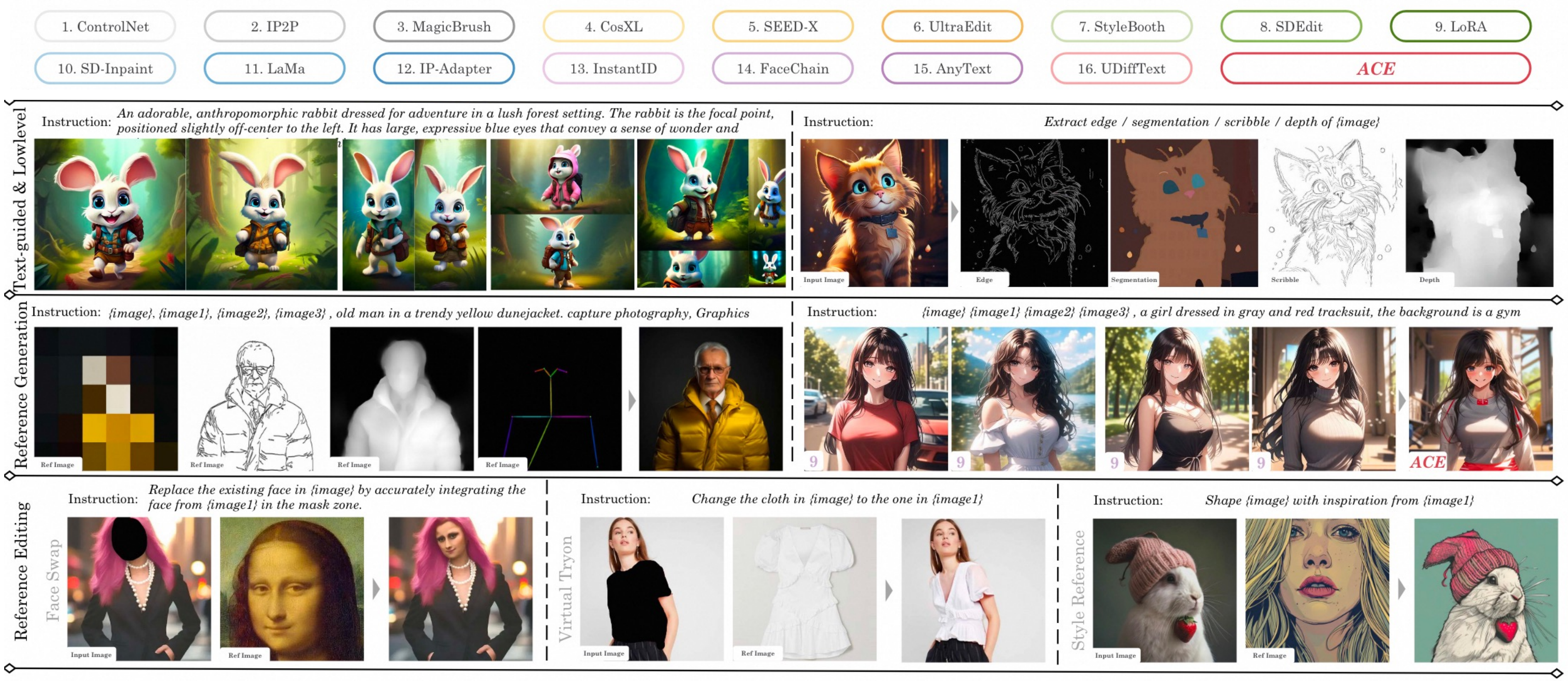


Model Performance and Applications

Visual Comparison

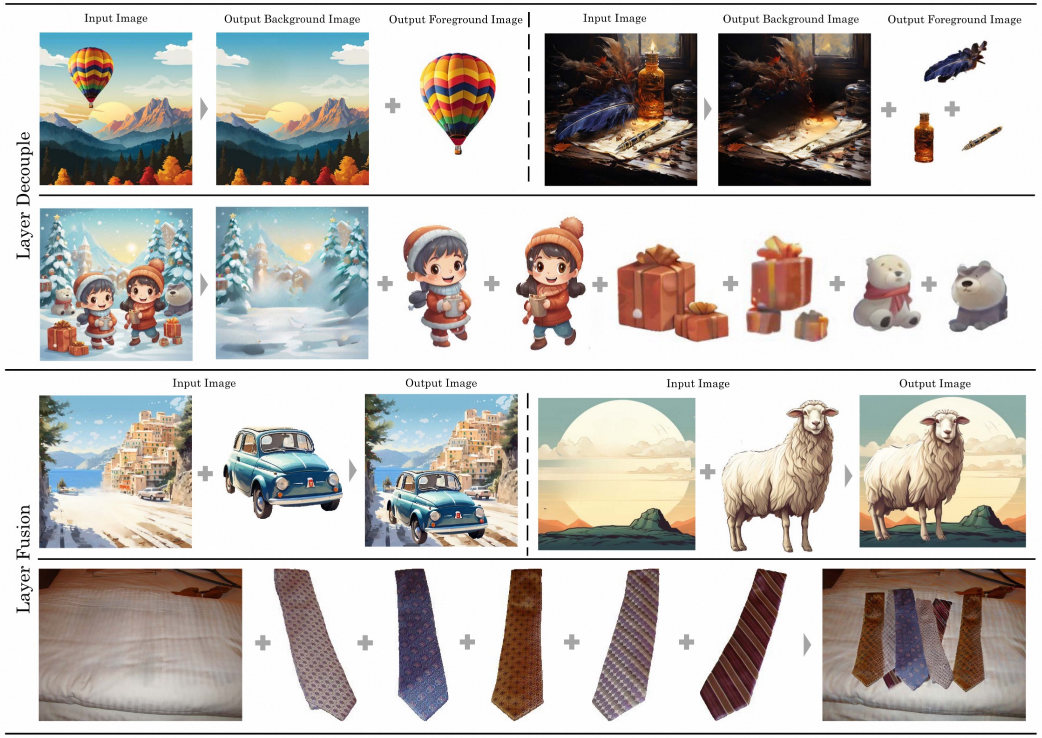
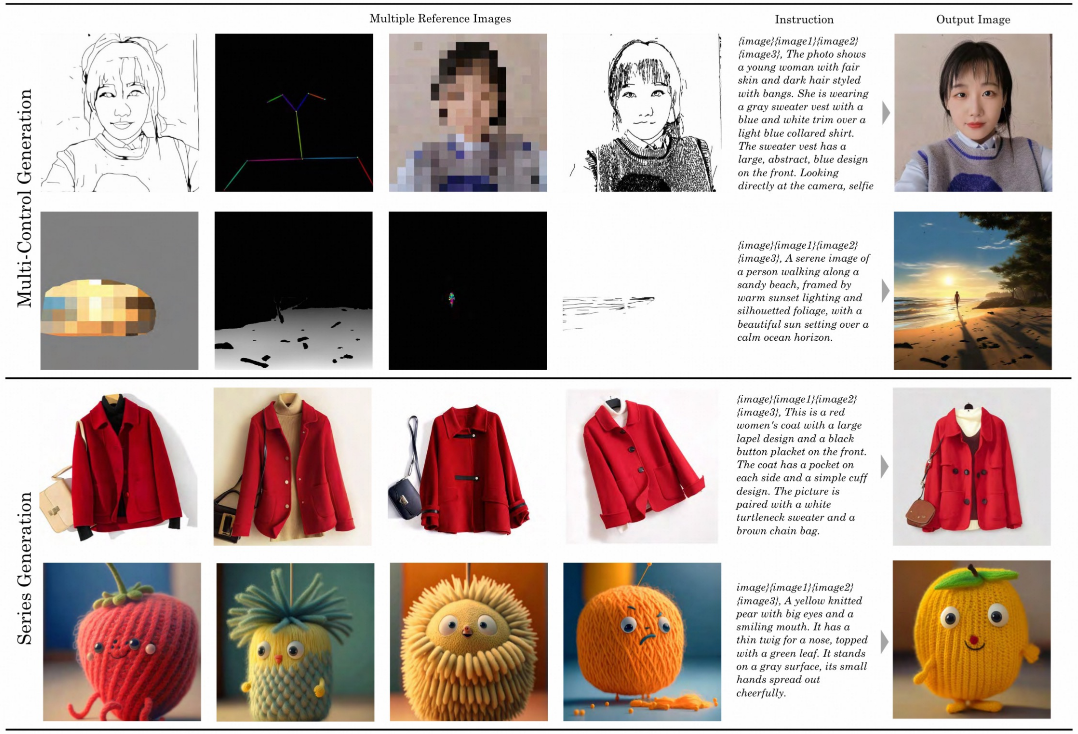


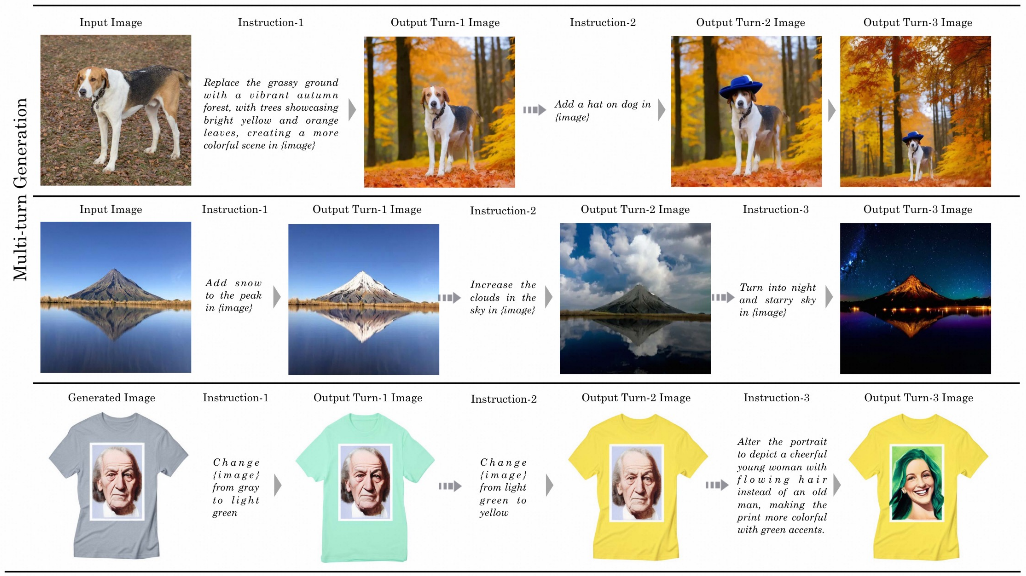
Image Layering Capability and Image Fusion Capability



Composite Generation and Reference Generation Capability

Model Performance and Applications

Visual Comparison

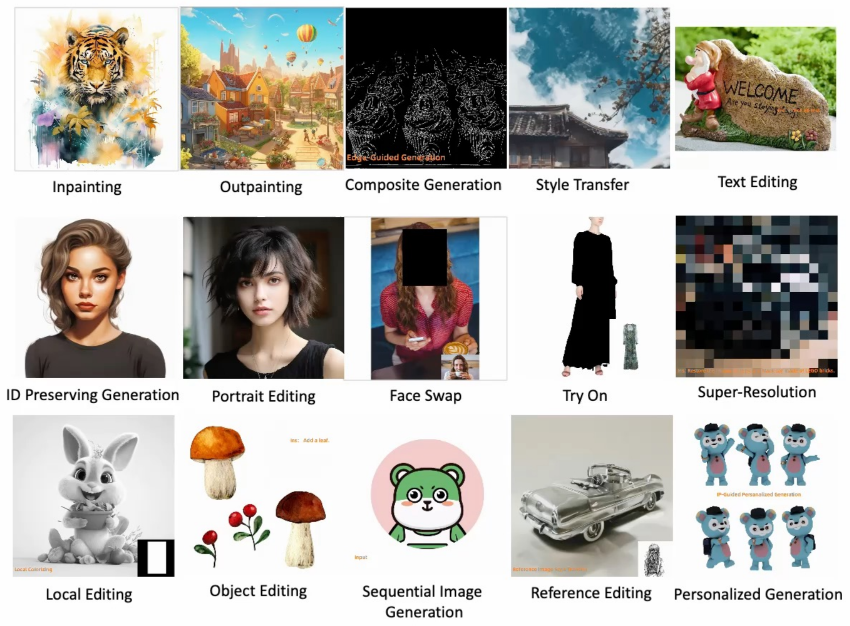


Multi-Round Editing and Identity Preservation Generation

Model Performance and Applications

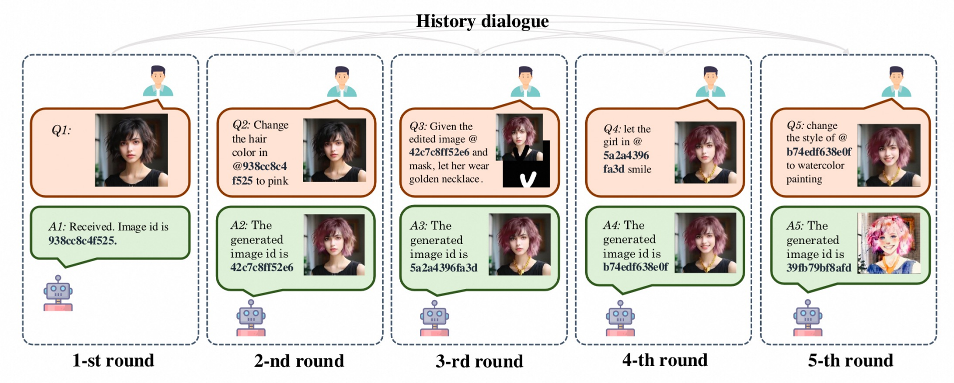
Applications: Basic Editing and Generation Tasks

- ✓ It can be used for 15 common image generation and editing tasks.
- ✓ Interactive generation and editing through instructions can significantly reduce deployment and usage costs.



Model Performance and Applications

Applications: Conversational Editing and Generation.



- ✓ In conversational mode, multi-round editing of images can be achieved through chat.

ACE Usage

Project Page：https://ali-vilab.github.io/ace-page/

https://github.com/ali-vilab/ACE/

https://huggingface.co/spaces/scepter-studio/ACE-Chat

https://www.modelscope.cn/studios/iic/ACE-Chat

Follow-up Works Related to ACE

ACE++: Instruction-Based Image Creation and Editing via Context-Aware Content Filling

✓ ACE++ is an upgrade Version based on post-training using FLUX-Dev.

Project Page: https://ali-vilab.github.io/ACE_plus_page/

https://github.com/ali-vilab/ACE_plus?tab=readme-ov-file

https://huggingface.co/spaces/scepter-studio/ACE-Plus

https://www.modelscope.cn/studios/iic/ACE-Plus

Follow-up Works Related to ACE

Wan2.1:

- ✓ The text data from ACE is used to train the Chinese and English text rendering capabilities of Wan 2.1.

Project Page: https://wanxai.com/

Wan https://wan.video

https://github.com/Wan-Video

https://huggingface.co/Wan-AI

https://www.modelscope.cn/models/Wan-AI/

Follow-up Works Related to ACE

ICEBench：A Unified and Comprehensive Benchmark for Image Creating and Editing

✓ ICEBench is a more refined definition and collection of ACEBench.

Project Page：https://ali-vilab.github.io/ICE-Bench-Page/

Follow-up Works Related to ACE

VideoACE: All-in-One Video Creation and Editing

- ✓ VideoACE is the adaptation of ACE for video tasks.

Project Page： https://ali-vilab.github.io/VACE-Page/

https://github.com/ali-vilab/VACE

Thanks

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Tongyi Lab, Alibaba Group