Layout-Corrector: Alleviating Layout Sticking Phenomenon in Discrete Diffusion Model

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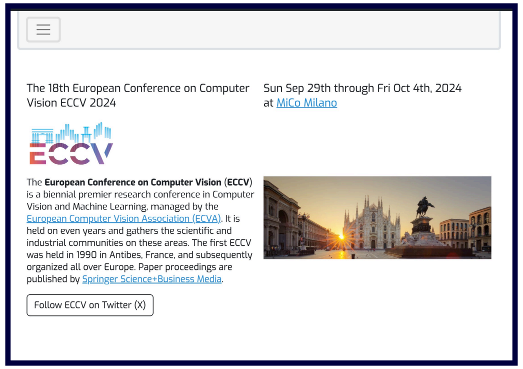
*This research was conducted during the internship at LY Corporation.

What is Layout?

ECCV2024
Website



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Sun Sep 29th through Fri Oct 4th, 2024 at MiCo Milano

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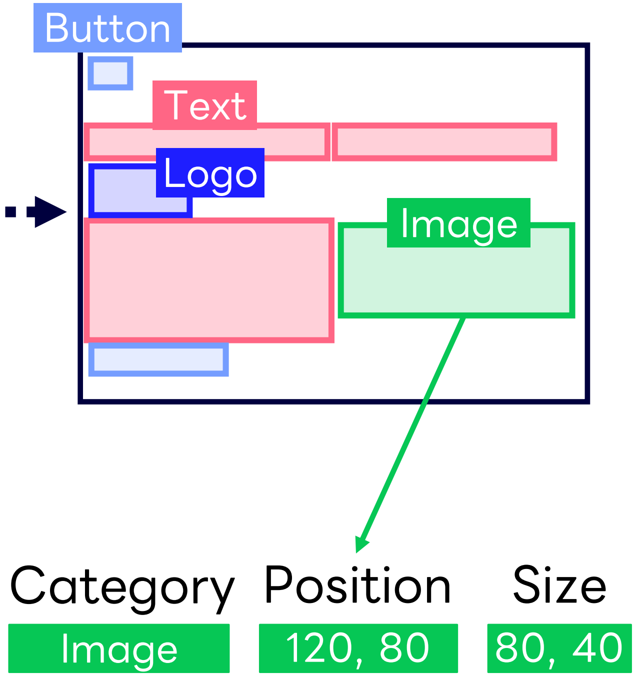
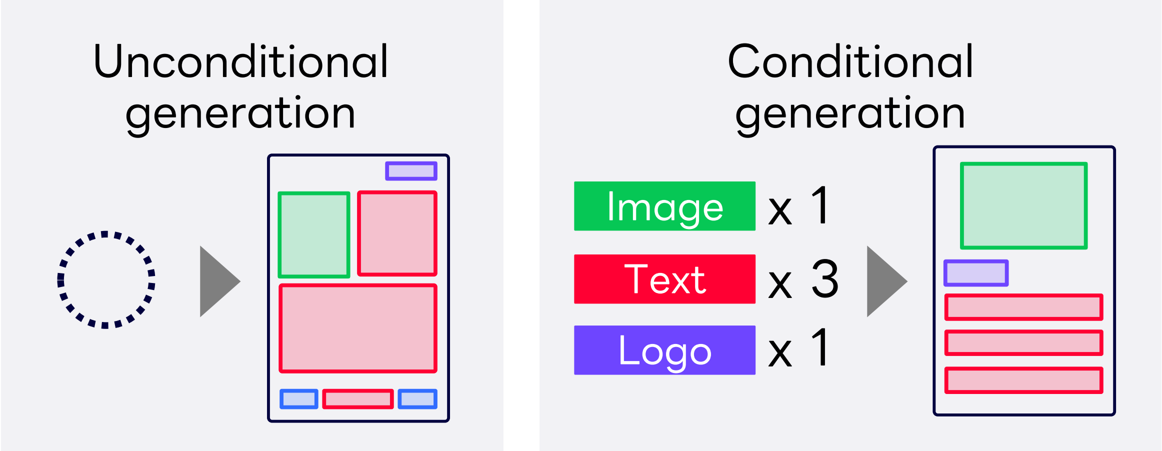
Layout:
Arrangement of elements



Category	Position	Size
Image	120, 80	80, 40

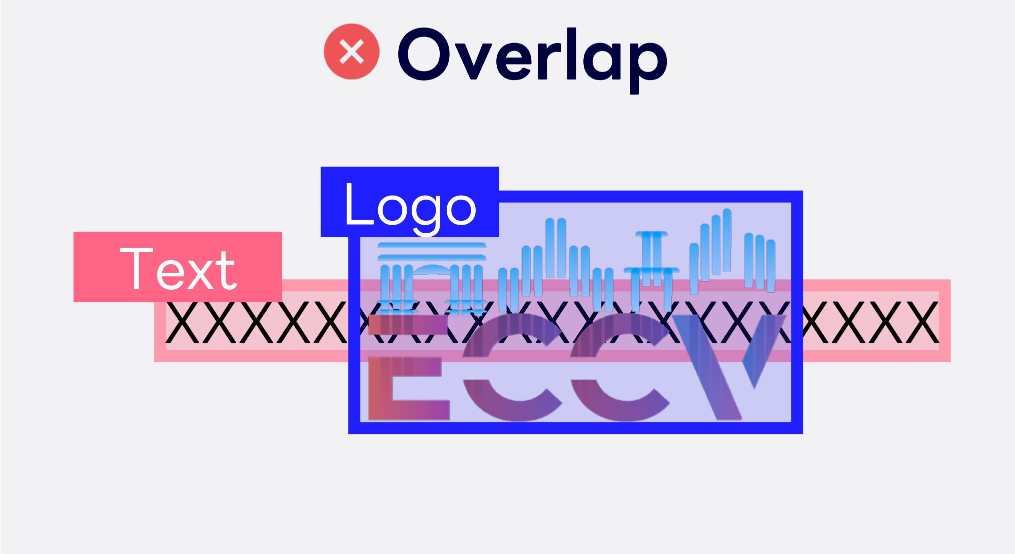
What is Layout Generation?

- Determine category, position, and size of each element.

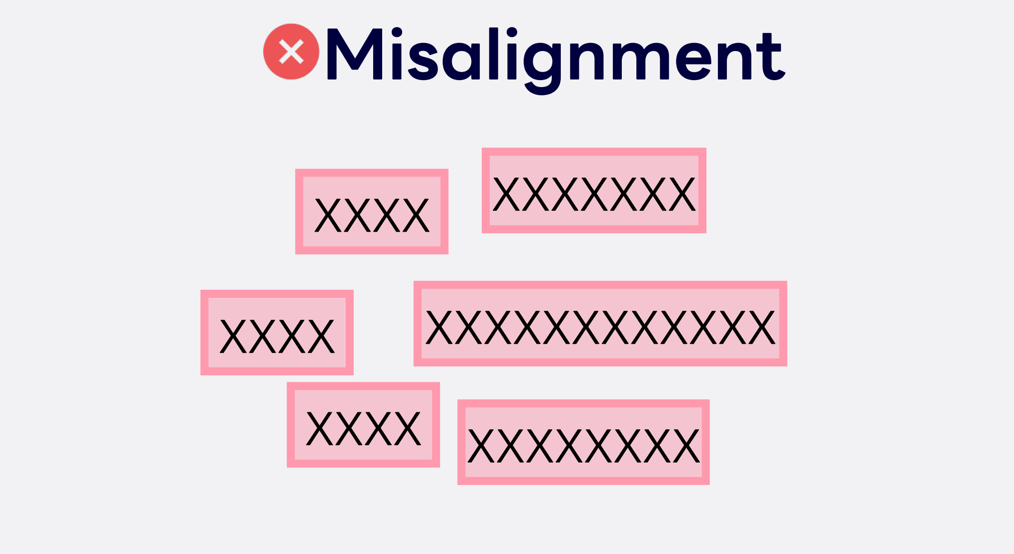


Goal: generating well-harmonized and high-quality layouts

Our goal: Avoiding Generation Error



✕ Overlap



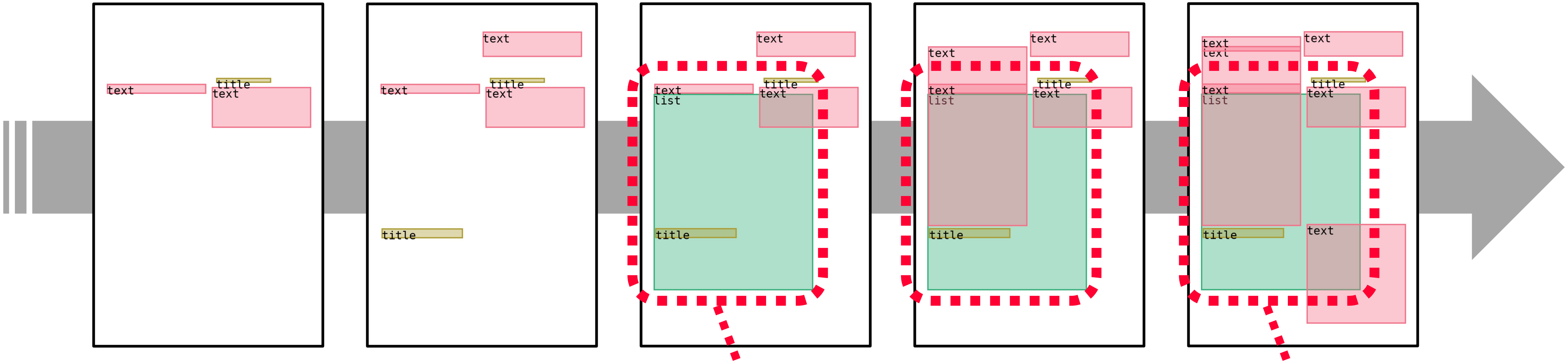
✕ Misalignment

Our goal: Avoiding Generation Error

✕ Existing Discrete Diffusion Model struggles to correct generation errors
= Generation errors got stuck! **(Layout-Sticking Problem)**

Generation process →

Final output



Error (Overlap) occurs

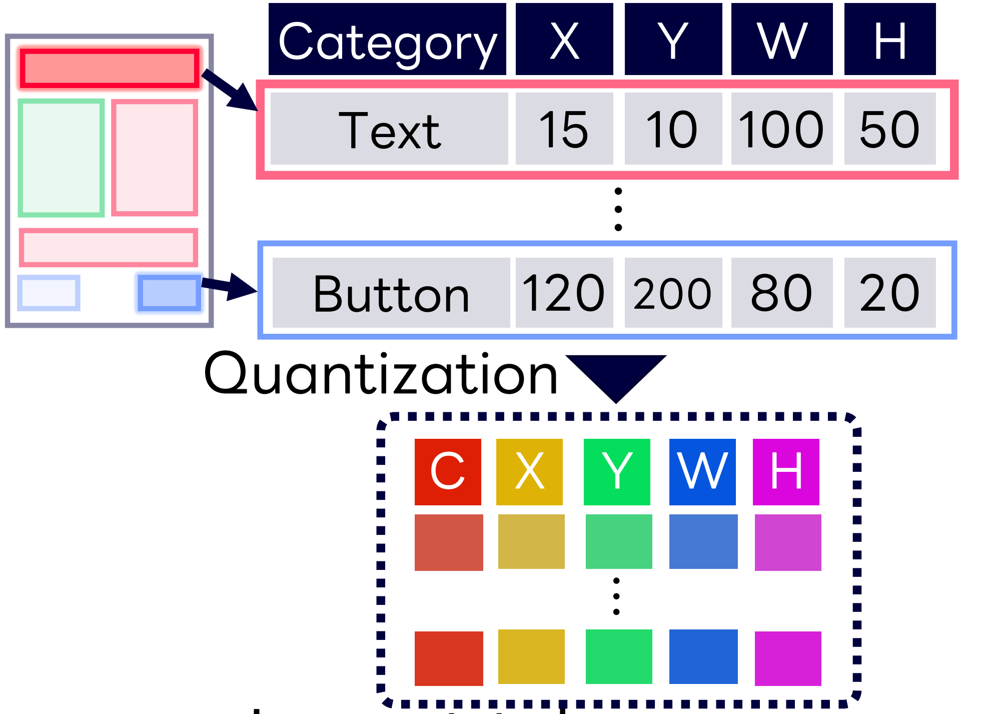
Error got stuck

→ **Our Layout-Corrector resets errors and prompts correction**

Layout Generation with Discrete Diffusion Model (DDM) [Inoue+, CVPR2023]

Layout Tokenization

Layout as Discrete Tokens

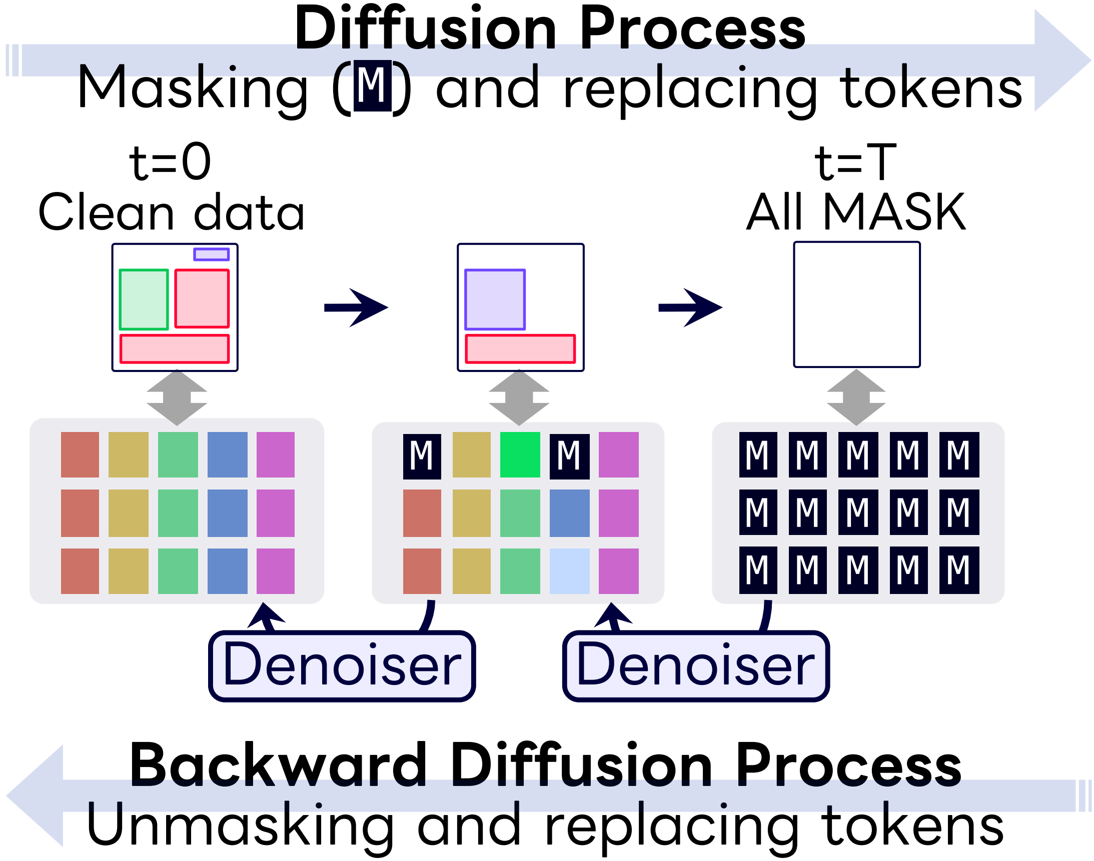


Category	X	Y	W	H
Text	15	10	100	50
⋮				
Button	120	200	80	20

Quantization

Layout token sequence

How DDM works



Diffusion Process

Masking (M) and replacing tokens

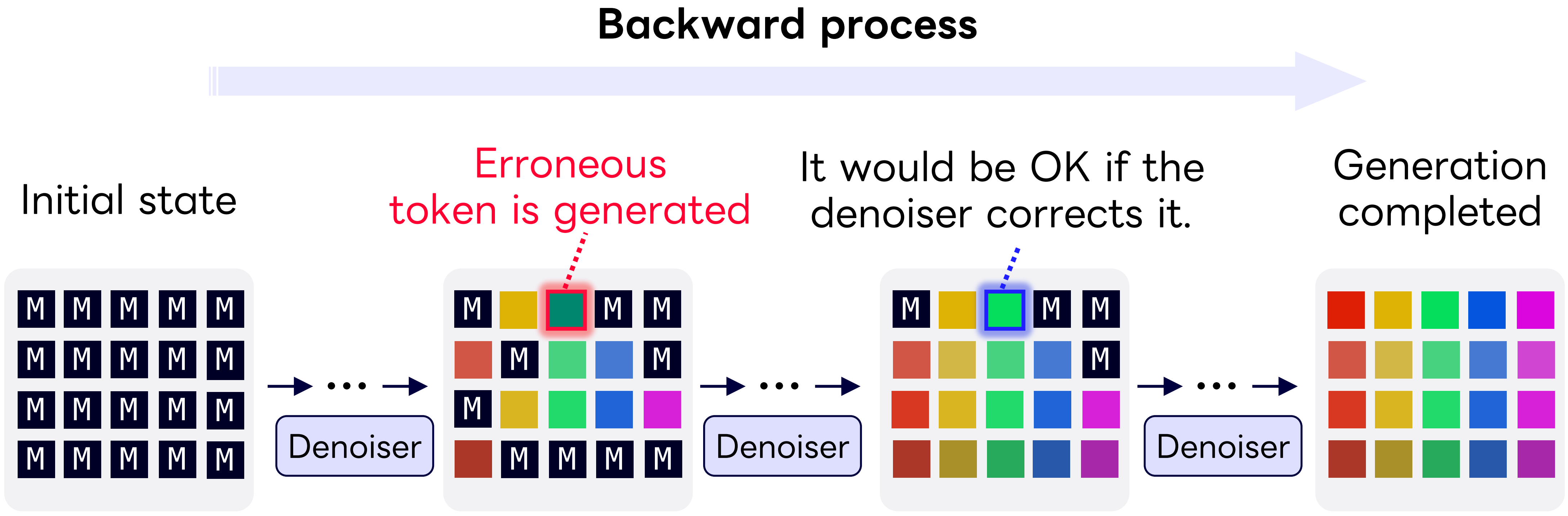
t=0
Clean data

t=T
All MASK

Backward Diffusion Process

Unmasking and replacing tokens

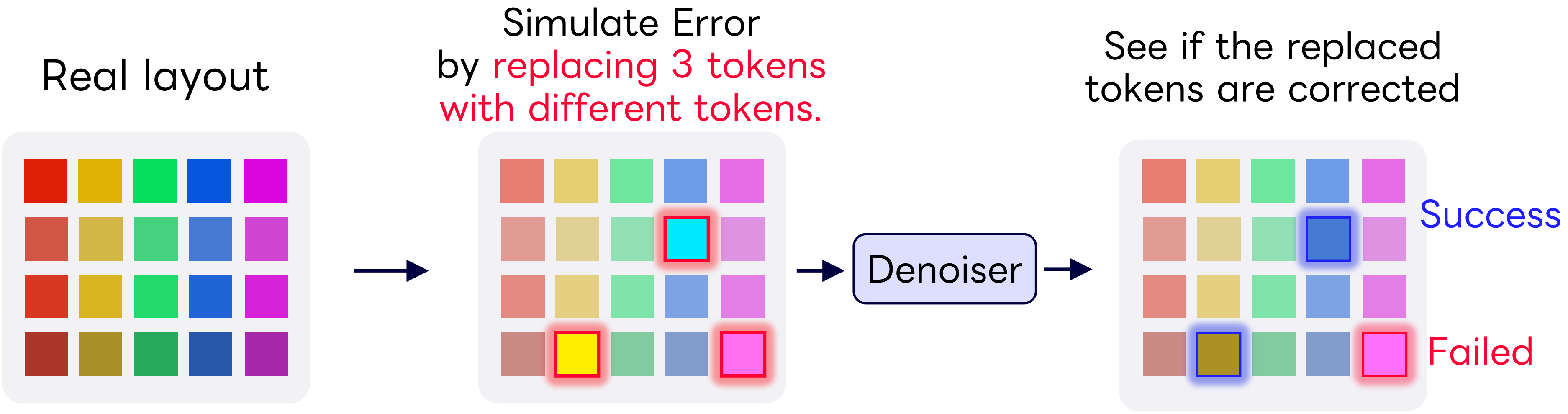
Layout Correction: A Solution to Generation Error?



Q. Can the Denoiser correct erroneous tokens?

Q. Can DDMs Correct Errors? A. Not so much

Experiment 1



Real layout

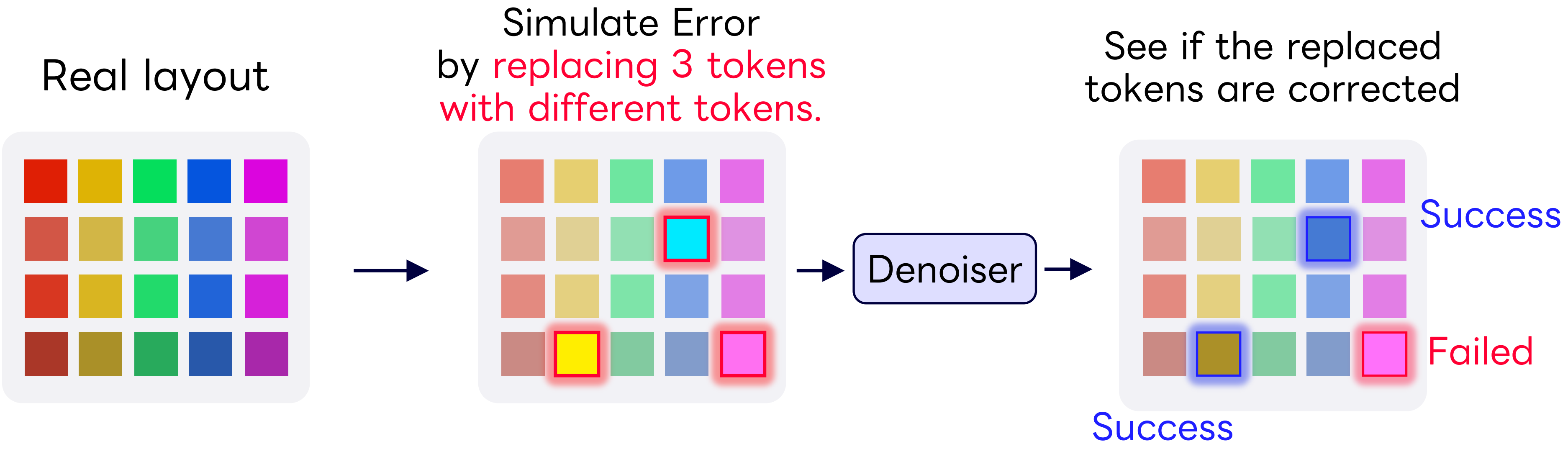
Simulate Error by replacing 3 tokens with different tokens.

Denoiser

See if the replaced tokens are corrected

Q. Can DDMs Correct Errors? A. Not so much

Experiment 1



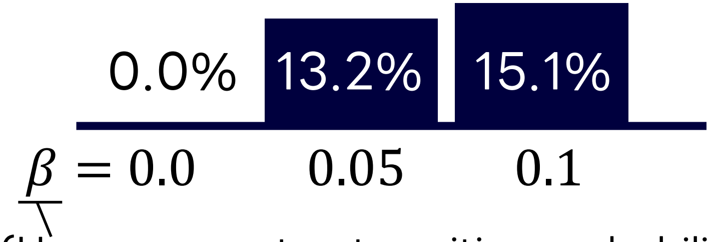
Real layout

Simulate Error by replacing 3 tokens with different tokens.

Denoiser

See if the replaced tokens are corrected

Correction success rate
(Exp. 1)



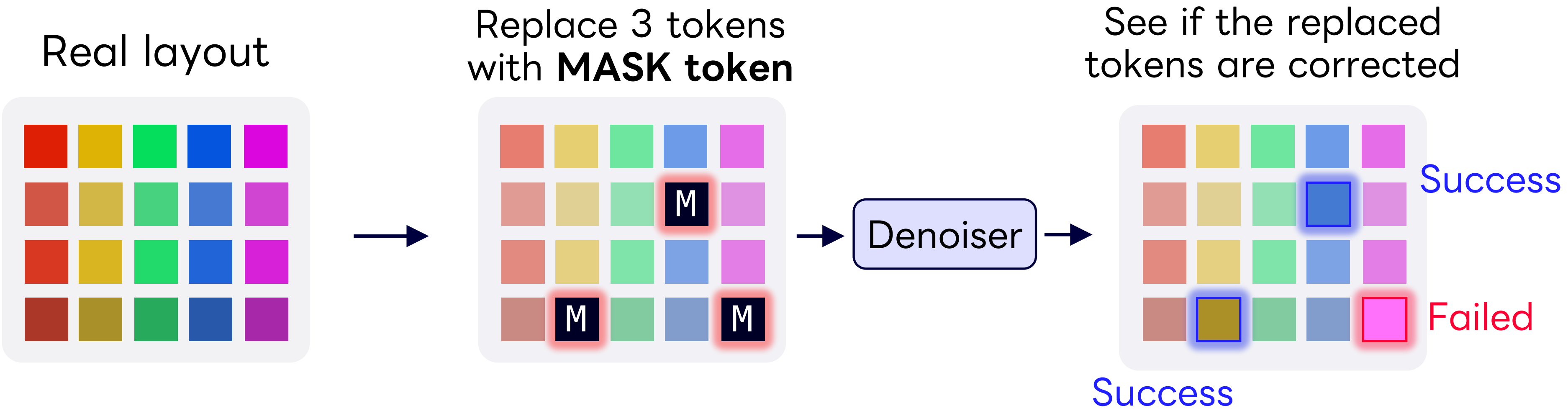
(Hyperparameter: transition probability between non-MASK tokens)

Highest Success rate: 15%

✕ DDMs struggle to correct errors, leading to layout-sticking problem

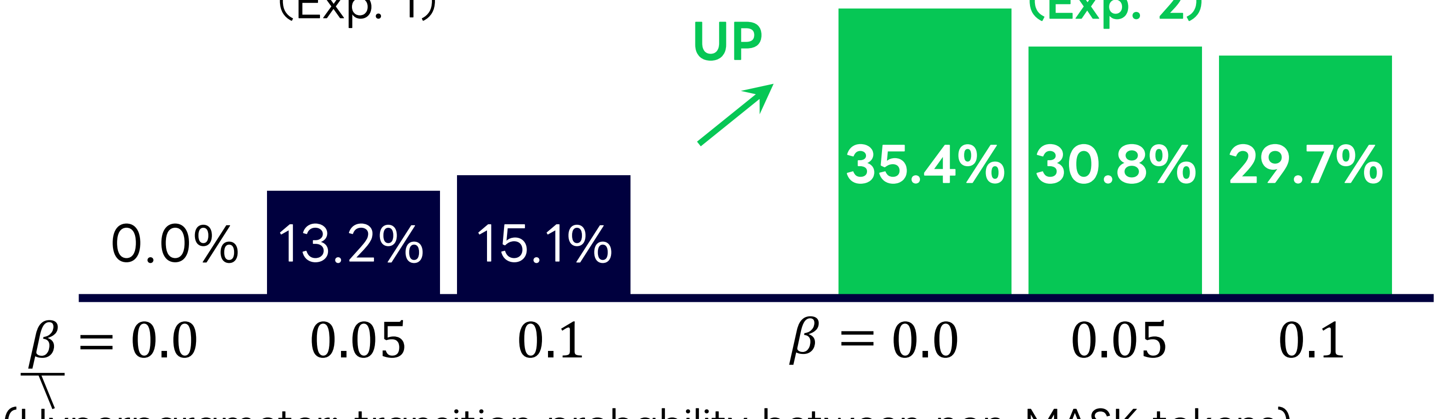
DDMs Perform Better When Reconstructing from MASK

Experiment 2


Real layout
Replace 3 tokens with **MASK token**
M
M
M
Denoiser
See if the replaced tokens are corrected
Success
Failed
Success

Correction success rate (Exp. 1)

Correction success rate (Exp. 2)



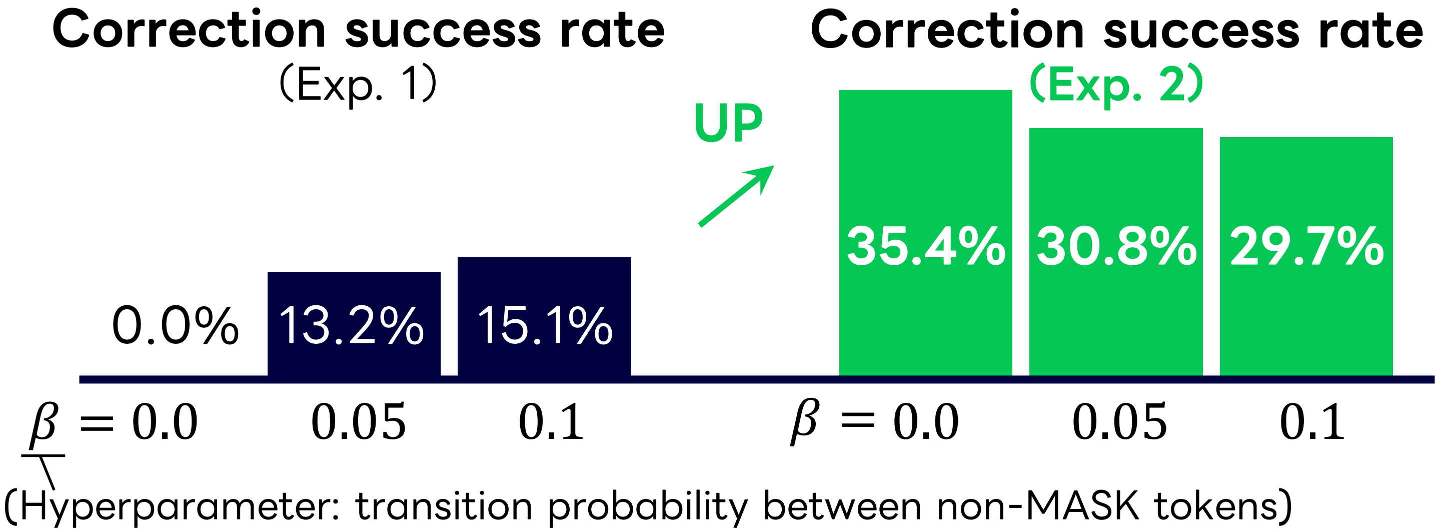
(Hyperparameter: transition probability between non-MASK tokens)

DDMs Perform Better When Reconstructing from MASK

Experiment 1 DDMs struggle to directly correct erroneous tokens

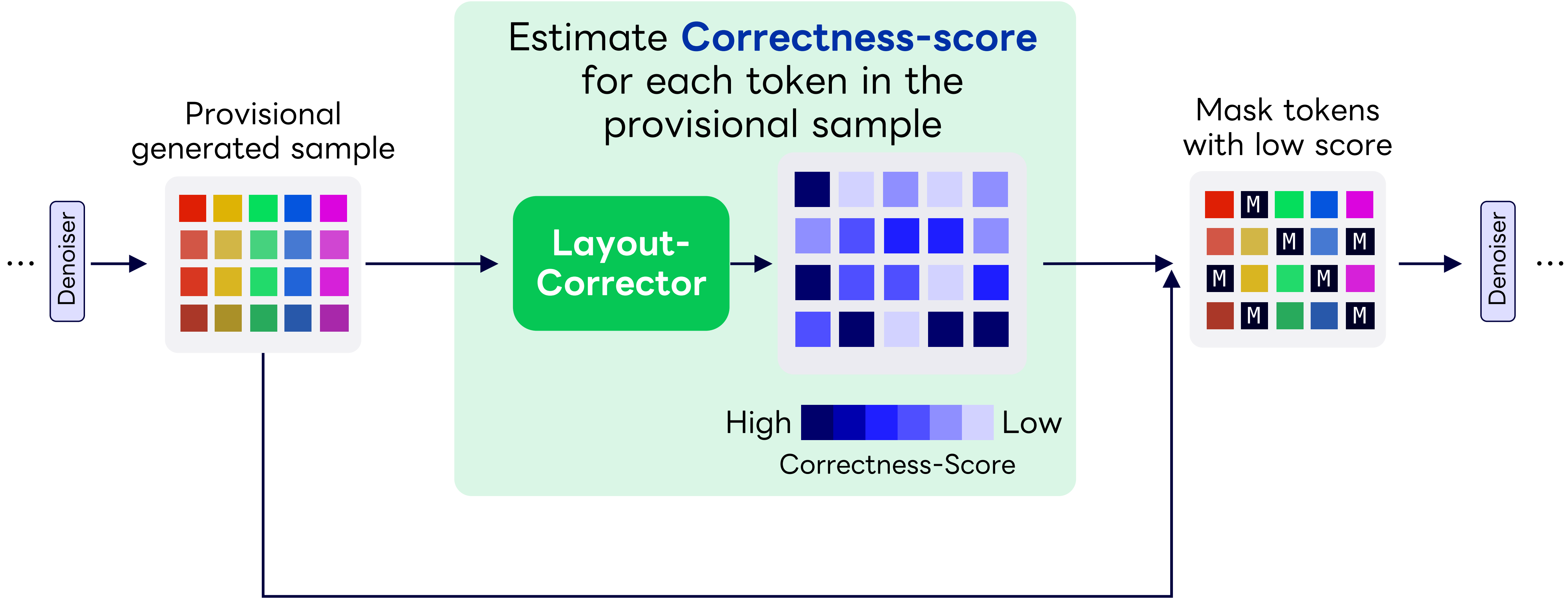
Experiment 2 If erroneous tokens are masked first, DDMs can correct them.

Propose Layout-Corrector,
which detects and masks erroneous tokens



Layout-Corrector: Overview

Detect erroneous tokens and mask them, prompting the DDM to correct them.



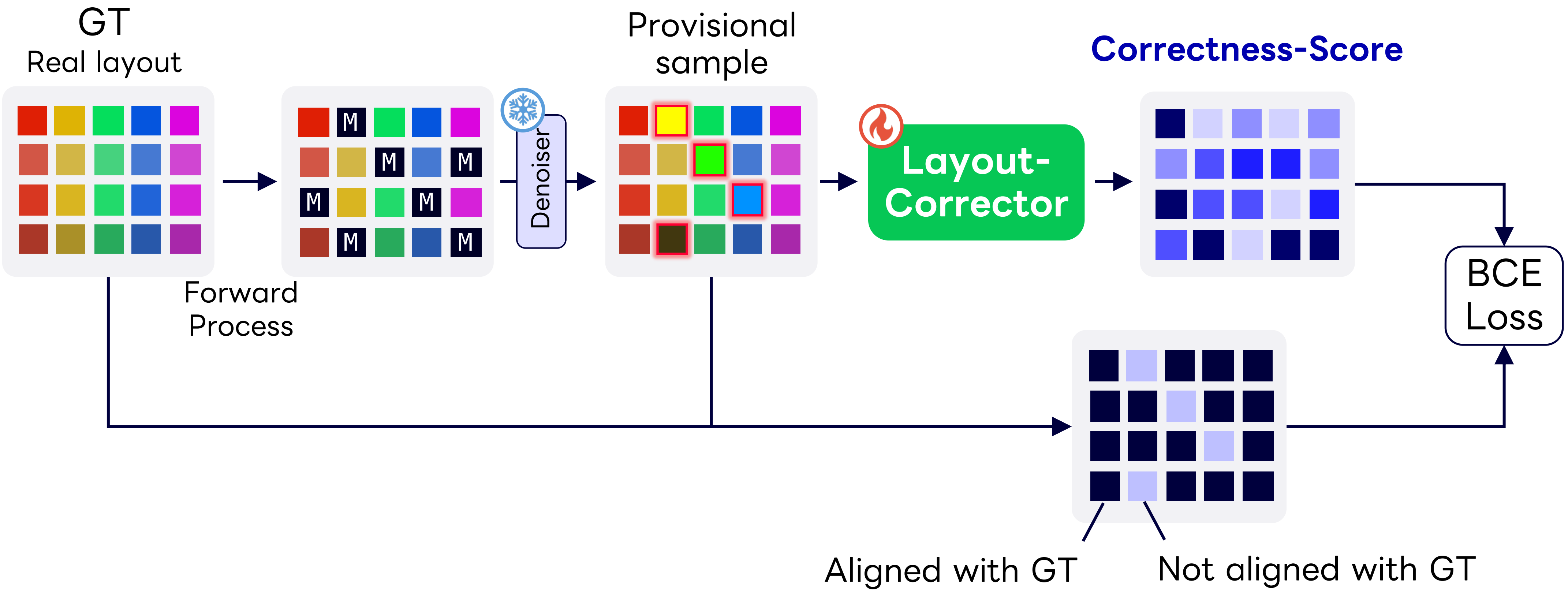
Provisional generated sample

Estimate **Correctness-score** for each token in the provisional sample

Mask tokens with low score

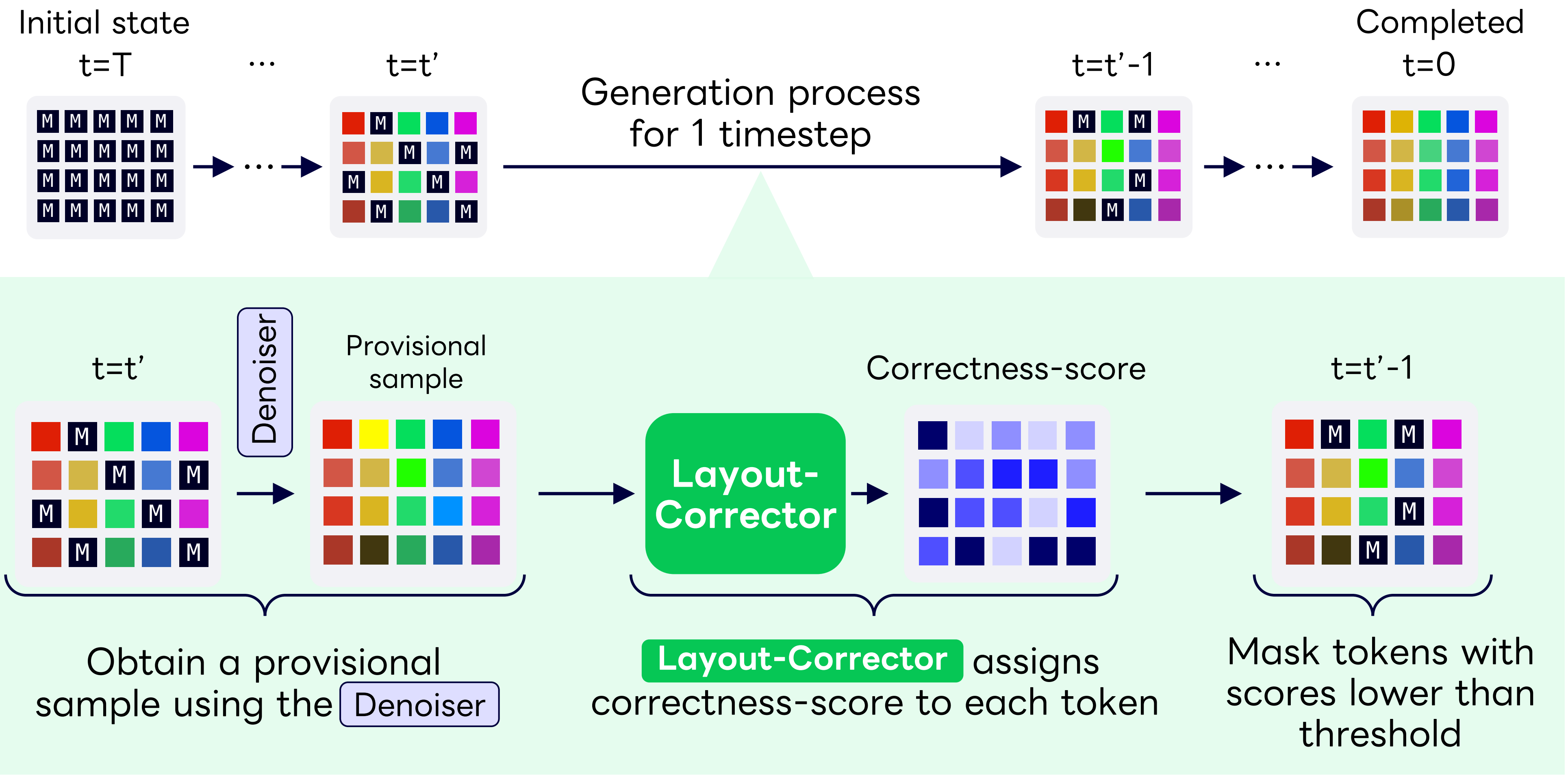
Layout-Corrector: Training

Train Layout-Corrector to predict whether each token in provisional sample with the corresponding ground-truth (real) layout.



→ Layout-Corrector learns to assign low score for tokens not aligning with GT (= erroneous tokens)

Layout-Corrector: Generating Process



Obtain a provisional sample using the Denoiser

Layout-Corrector assigns correctness-score to each token

Mask tokens with scores lower than threshold

We selectively apply Layout-Corrector at specific 3 timesteps out of T=100 timesteps

Layout-Corrector (LC) improved performance of multiple baselines

Quantitative Evaluation (FID↓)

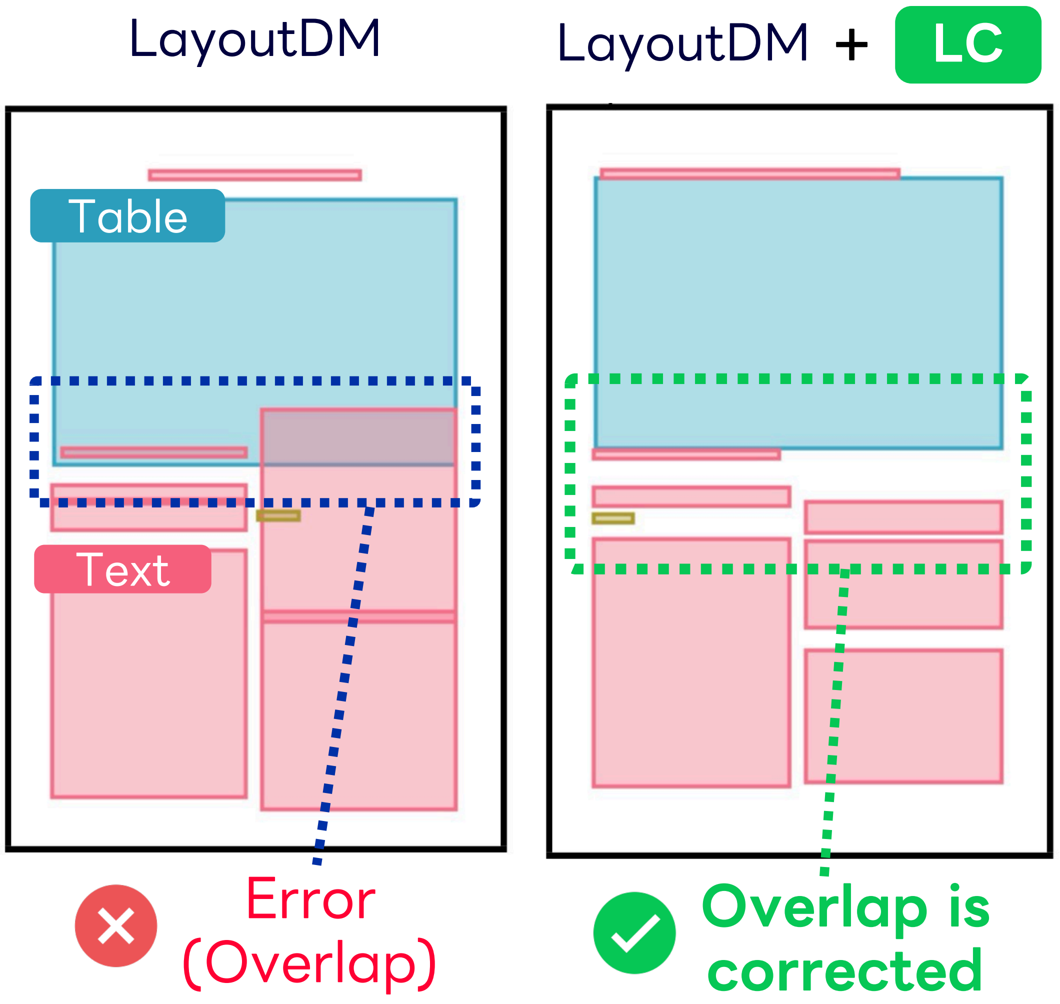
dataset:	Rico	PubLayNet
Baseline generation model 1		
MaskGIT only	70.4	34.2
MaskGIT + TC	15.7	17.6
MaskGIT + LC	**14.4**	**13.7**
Baseline generation model 2		
LayoutDM only	6.37	13.7
LayoutDM + TC	17.97	22.3
LayoutDM + LC	**4.79**	**11.9**

✓ **Improved performance of two baselines**

✓ **Outperformed existing method, TC** (Token-Critic)

TC (Token-Critic): [Lezama+, ECCV2022]
MaskGIT: [Chang+, CVPR2022]
LayoutDM: [Inoue+, CVPR2023]

Generated sample (PubLayNet dataset)



Conclusion

Summary

Goal

Correct generation error in layout-generation

Preliminary

DDM cannot directly correct erroneous tokens

DDM can correct erroneous tokens if we could mask them

Method

Layout-Corrector detects erroneous tokens and mask them

Experiment

Improve multiple baseline layout-generation models

More results in our paper

Layout-Corrector can also:

✓ Improve conditional generation

✓ Control fidelity-diversity trade-off

✓ Mitigate performance drop caused by fast-sampling

✓ Evaluate discrepancy between generated and real layouts