Exhibit Hall C,D,E
Wed. 3 Dec. 4:30 P.M.

ReDi: Rectified Discrete Flow

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Discrete Flow-based Models (DFMs)

Discrete Flow-based models learn $p_\theta(X_1|X_0)$, where X_1 is data and X_0 is initial state.

Masked Generative Models[1]

Uniform Diffusion

Sampling step: 0/8

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many water during of to water put without thought between necessary million now go
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Absorbing Diffusion

Sampling step: 00/30

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Diffusion Language Models[2]

[1] https://masked-generative-image-transformer.github.io/
[2] https://s-sahoo.com/duo/

What hinders DFM's few-step generation?

DFMs are based on the **factorized modeling** to treat high-dimensional data.

$$p(X_{t+h}|X_t) = \prod_{i=1}^{N} p(X_{t+h}^{(i)}|X_t) + o(h)$$

Joint Modeling

→ D^N logits

Factorized Modeling

→ D x N logits

What hinders DFM's few-step generation?

The necessity of **factorized modeling** introduces **factorization error** that hinders few-step generation of DFMs.

$$p(X_1|X_0) \neq \prod_{i=1}^{N} p(X_1^{(i)}|X_0)$$

Joint Modeling

Factorized Modeling

What hinders DFM’s few-step generation?

We adopt **conditional Total Correlation(TC)** to characterize the factorization error.

$$TC_\pi(X_1|X_0) = \mathbb{E}_{x_0}[D_{KL}(p(X_1|X_0 = x_0)||\prod_{i=1}^{N} p(X_1^{(i)}|X_0 = x_0))]$$

What hinders DFM's few-step generation?

We observe that the conditional TC depends on the coupling $\pi(X_0, X_1)$.

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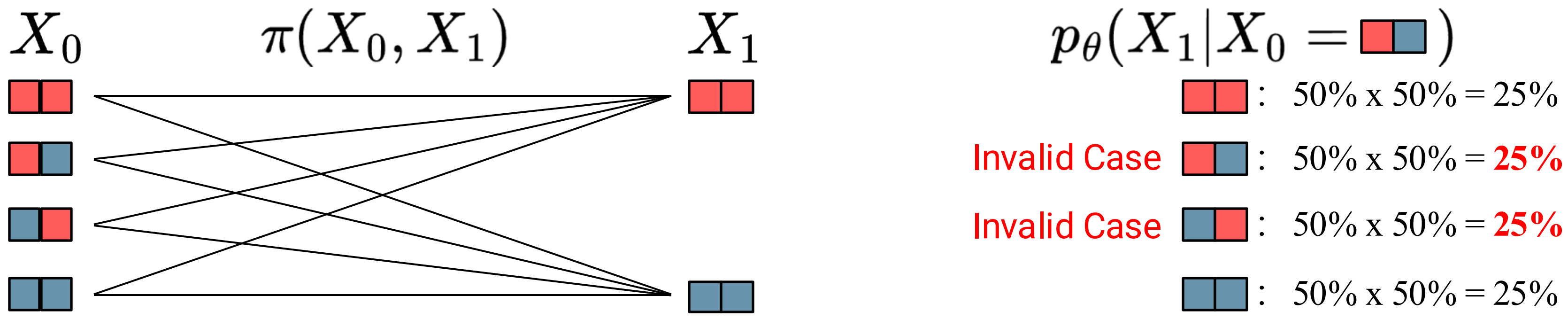
$$= \frac{\pi(X_0 = x_0, X_1)}{p(X_0 = x_0)}$$

What hinders DFM's few-step generation?

We observe that the conditional TC depends on the coupling $\pi(X_0, X_1)$.



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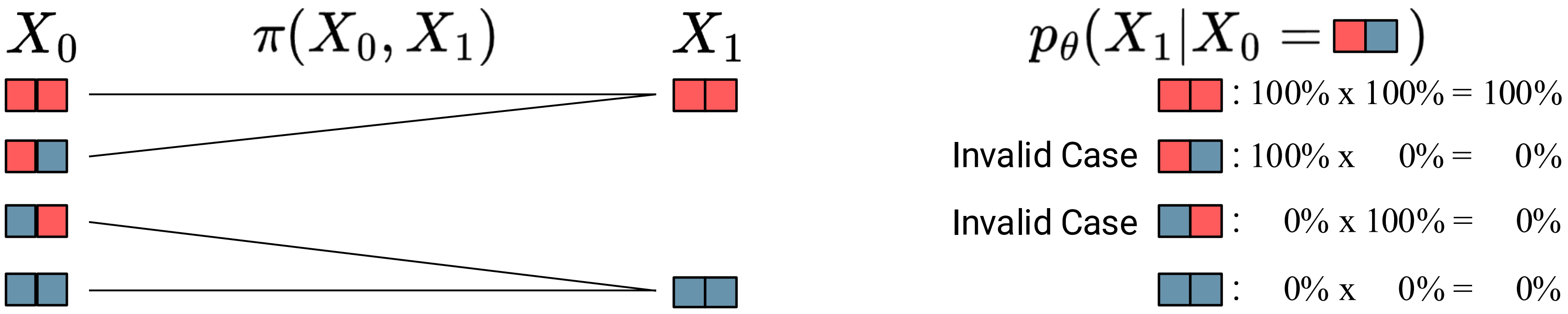


ReDi: Rectified Discrete Flow

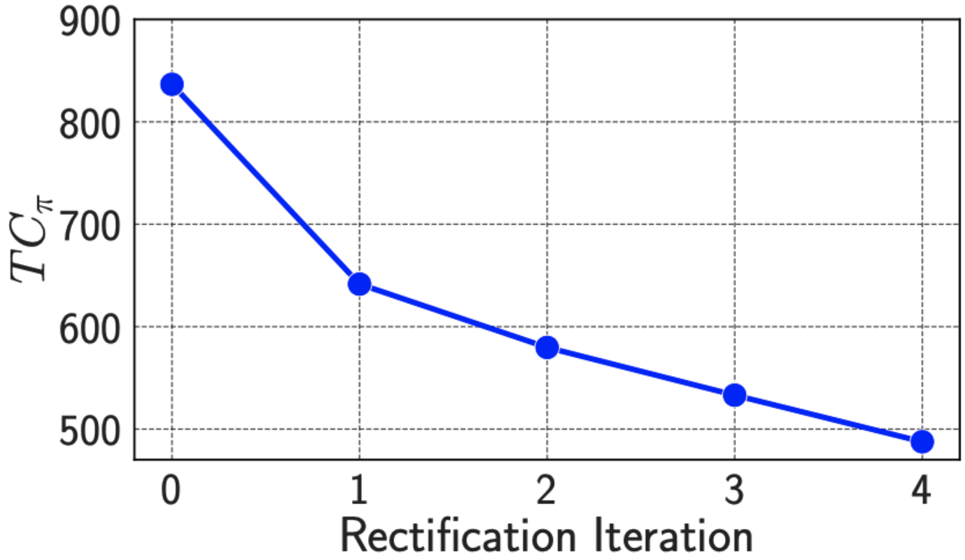
We propose to **rectify the coupling** to reduce the conditional Total Correlation.

$$\pi_{k+1}(X_0, X_1) = p(X_0)\underbrace{p_\theta(X_1|X_0)}_{\text{Data Generation}}$$

ReDi: Rectified Discrete Flow

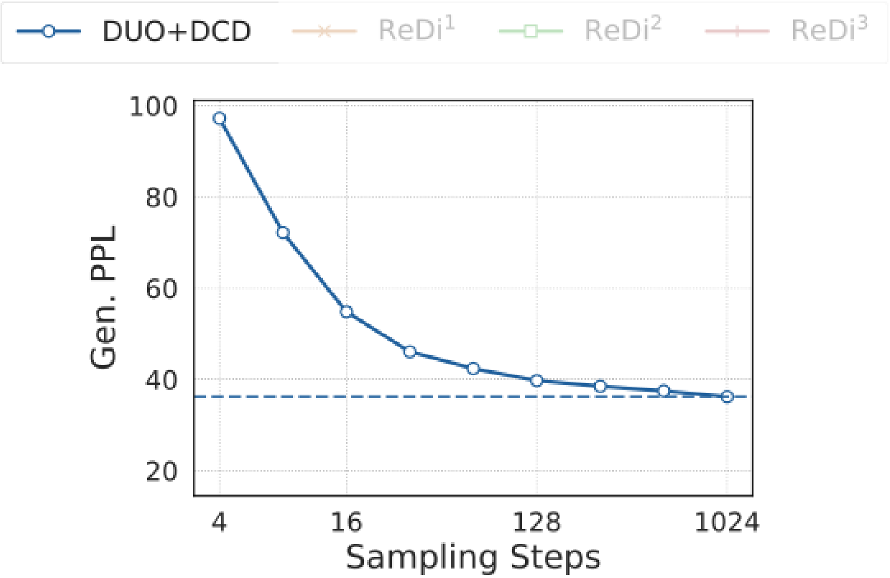
Theoretical Result: each rectification iteration reduces conditional Total Correlation.

$$TC_{k+1}(X_1|X_0) \leq TC_k(X_1|X_0)$$



ReDi on Text Generation

ReDi enhances few-step performance of the teacher models on OpenWebText.



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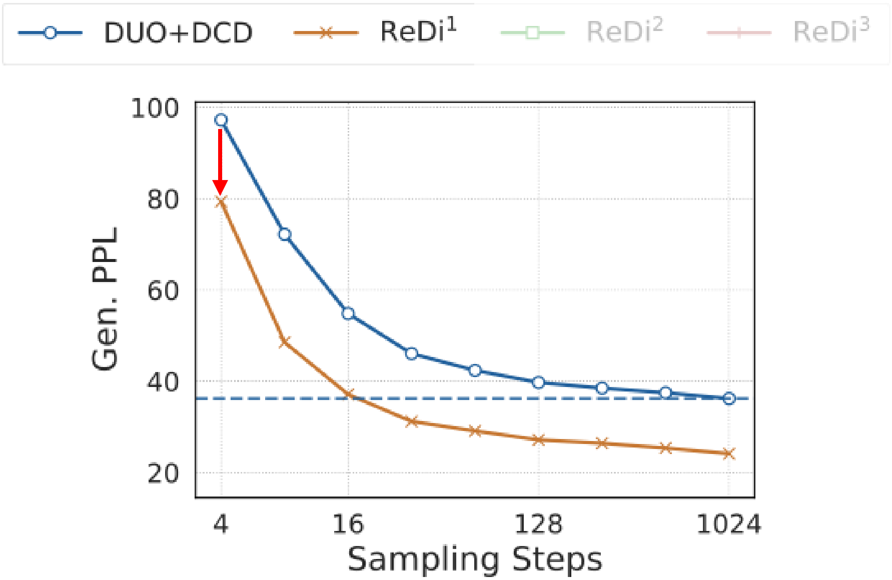

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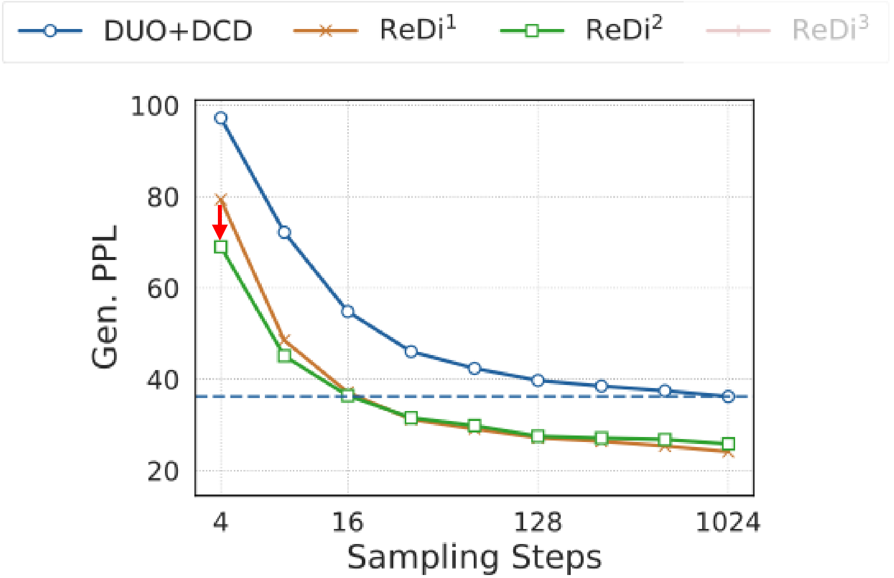
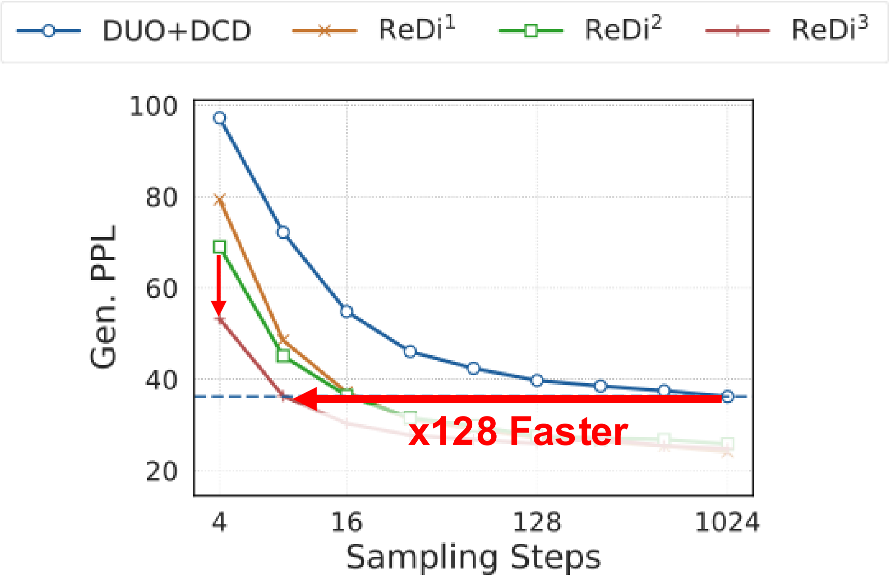


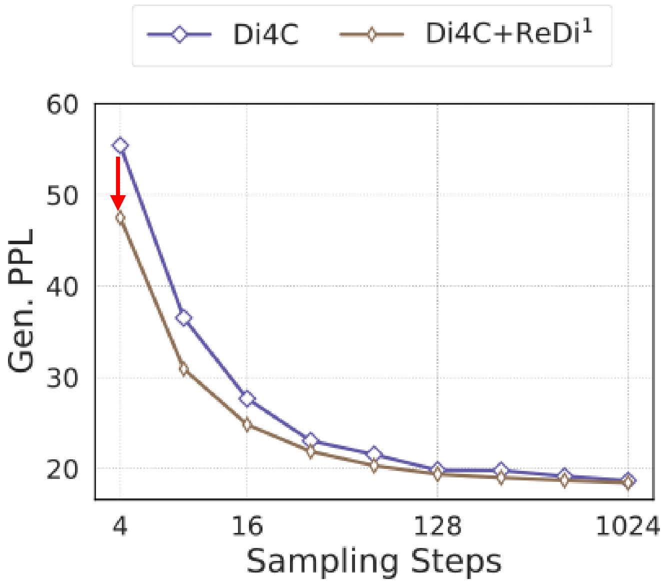
ReDi on Text Generation

ReDi accelerates the teacher model by up to **128x.**



ReDi on Text Generation

ReDi can be **combined with other distillation** method.

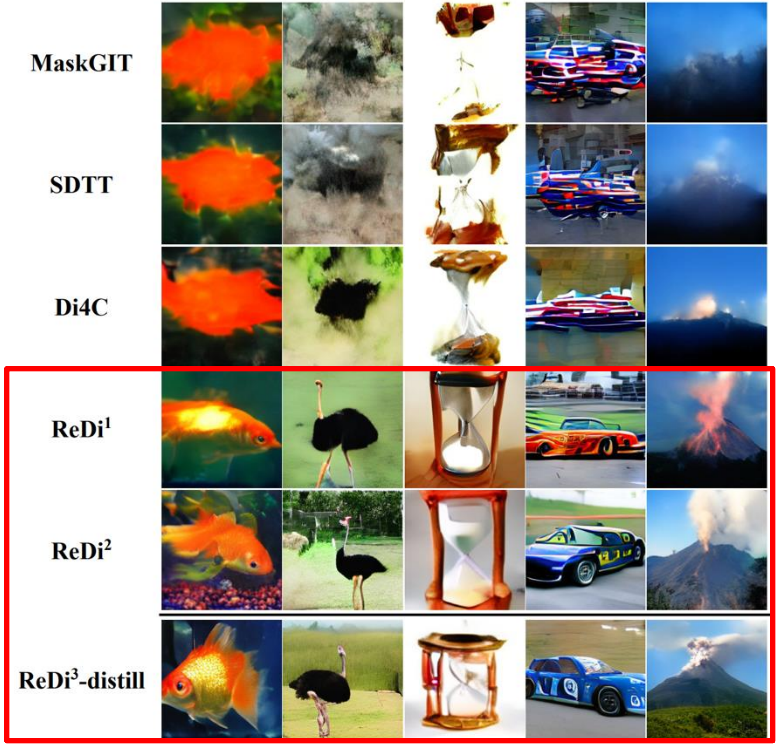


ReDi on Image Generation

ReDi enables **1-step generation** on class-conditional ImageNet.

Step	Model	FID (↓)	IS (↑)
1	MaskGIT [3]	95.16	12
	SDTT† [10]	90.40	14
	Di4C [17]	90.32	13
	ReDi^1	37.43	49
	ReDi^2	21.80	90
	ReDi^3-distill	**11.68**	**182**

1-step Generation Results



Conclusion

- **Factorization error** hinders few-step generation.
- Factorization error can be characterized with **conditional Total Correlation** which **depends on the coupling.**
- We proposed **ReDi, rectifying the coupling** to reduce the factorization error.

For more details, please join our poster session.

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arXiv

code