

KD-DLGAN: Data Limited Image Generation via Knowledge Distillation

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Background and Motivation

- GANs have achieved great successes in various image generation tasks:
 - Image-to-image translation
 - Domain adaptation
 - Super resolution
 - Image in-painting
- Training effective GANs requires large amounts of training data:
 - Discriminator over-fitting without sufficient data
 - Data collection is laborious and time-consuming



Background and Motivation

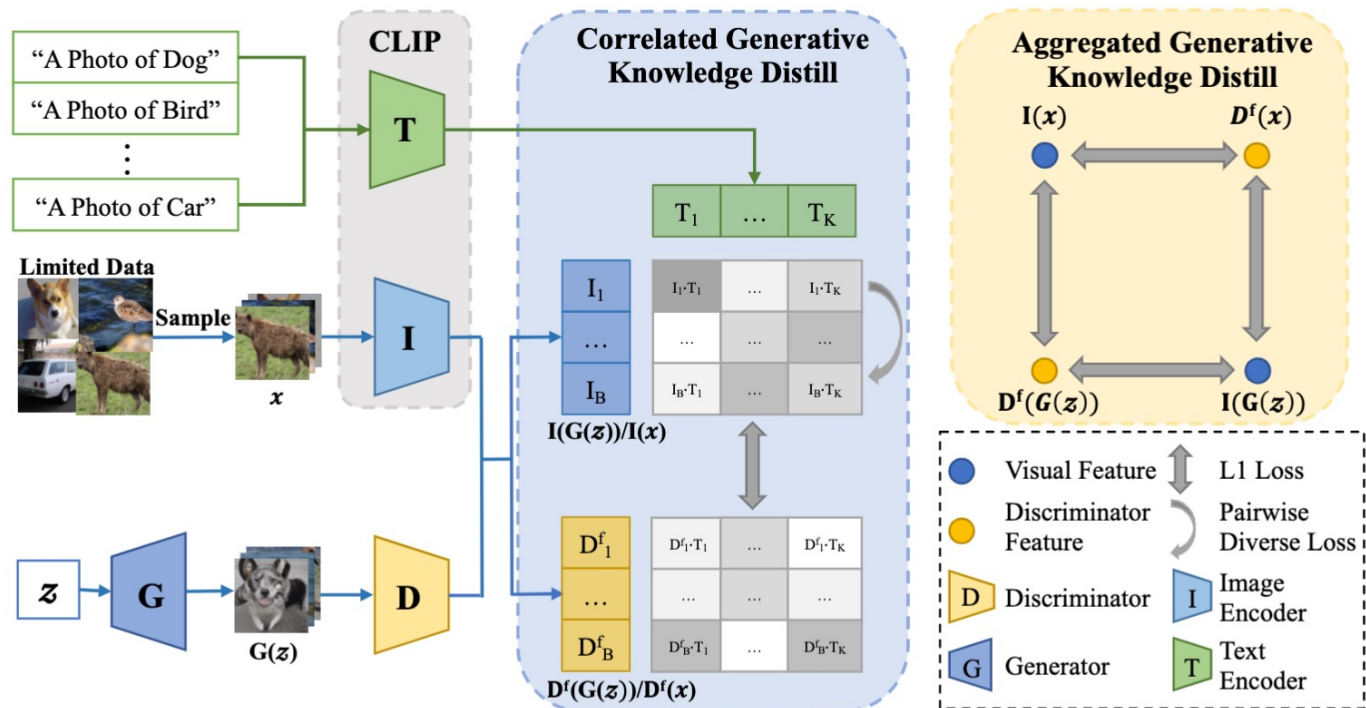
- Previous solution to mitigate overfitting
 - Data augmentation
 - Model regularization
- Our solution:
 - Knowledge distillation



Proposed Method: KD-DLGAN

- Synthesis Framework

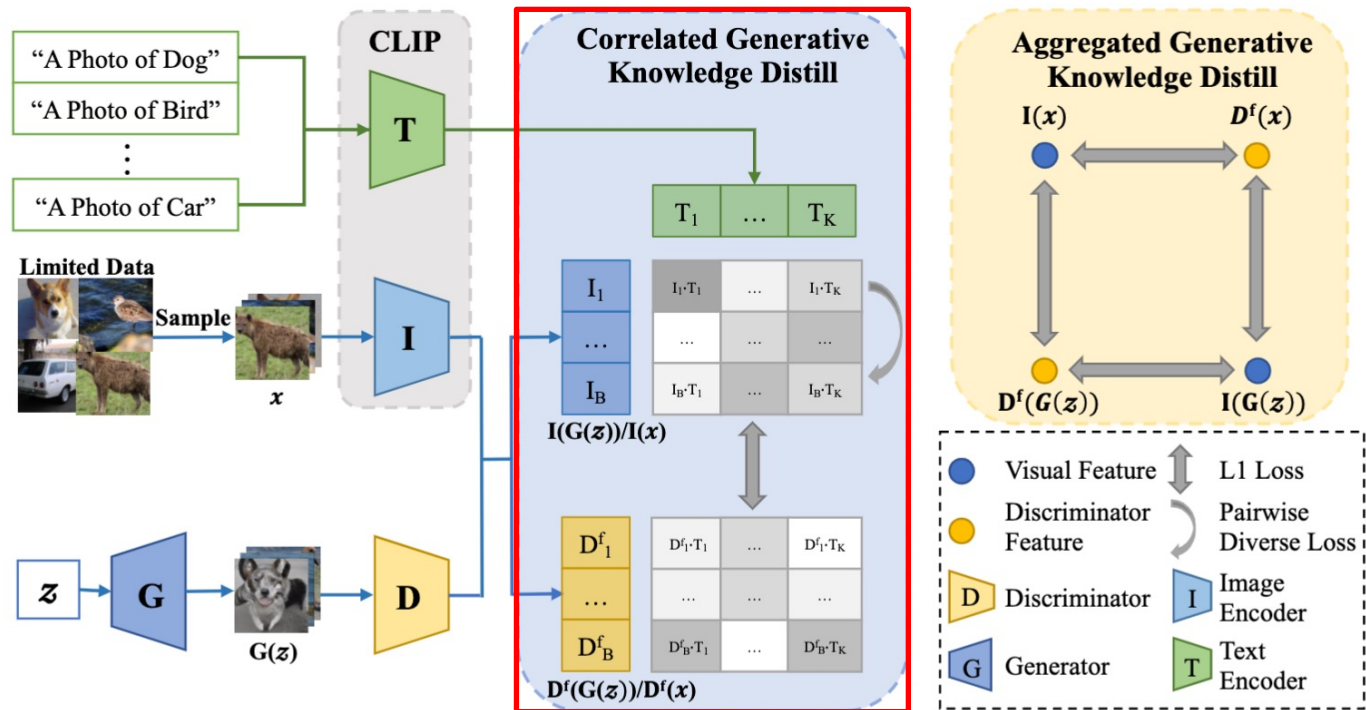
- Correlated Generative Knowledge Distill
- Aggregated Generative Knowledge Distill



Proposed Method: KD-DLGAN

- Synthesis Framework

- Correlated Generative Knowledge Distill
- Aggregated Generative Knowledge Distill

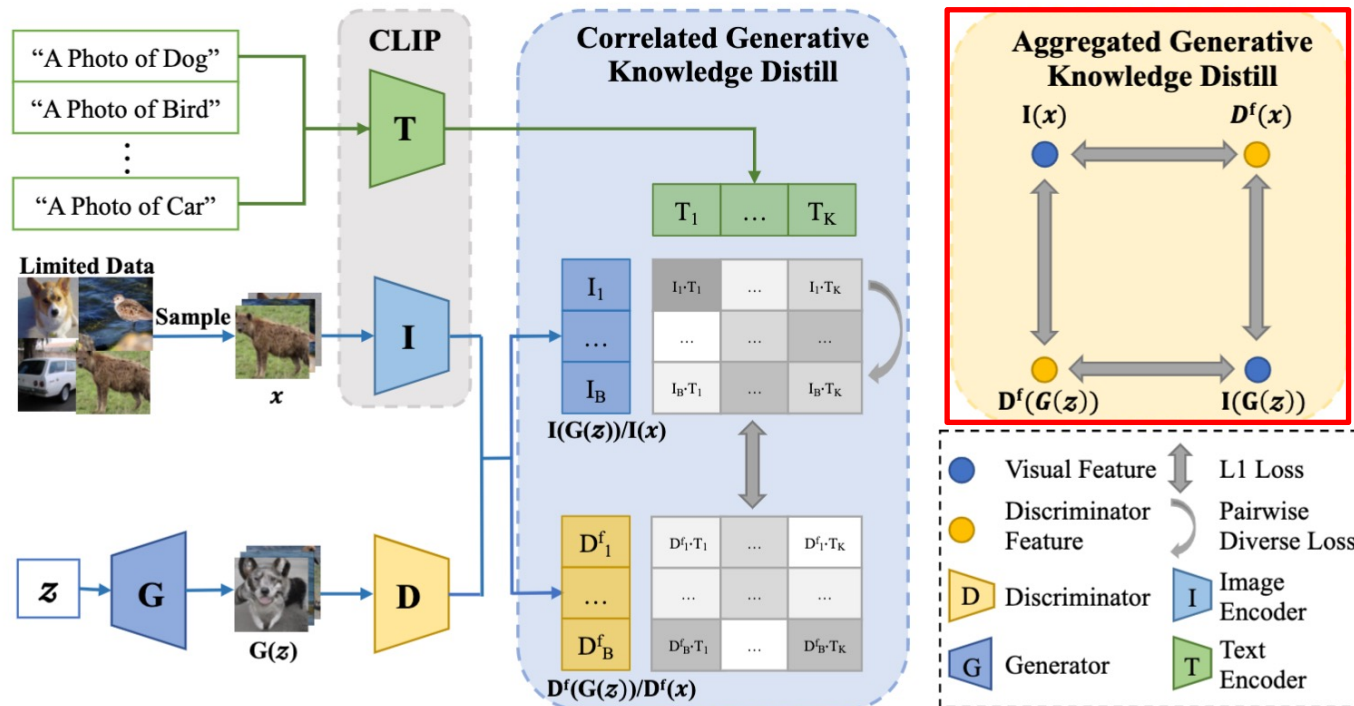


Proposed Method: KD-DLGAN

- Synthesis Framework

- Correlated Generative Knowledge Distill

- Aggregated Generative Knowledge Distill



Proposed Method: KD-DLGAN

- Experimental Data

- CIFAR

- 50K training images and 10k test images
 - Resolution: 32 * 32
 - 100%, 20%, 10% samples

- 100 Shot

- 100-shot Obama, Grumpy cat, Panda
 - Resolution: 256 * 256
 - All samples

- AFHQ

- 160 AFHQ-Cat images and 389 AFHQ-Dog images
 - Resolution: 256 * 256
 - ALL samples

- ImageNet

- 1.2M training images
 - Resolution: 64 * 64
 - 10%, 5%, 2.5% samples



Proposed Method: KD-DLGAN

- Synthesis Results (100 Shot and AFHQ)

Methods	100-shot			AFHQ	
	Obama	Grumpy Cat	Panda	Cat	Dog
DA [53] + KD (CLIP [36])	45.22	25.62	11.24	38.31	55.13
DA [53] (Baseline)	46.87	27.08	12.06	42.44	58.85
+ KD-DLGAN (Ours)	31.54 ± 0.27	20.13 ± 0.13	8.93 ± 0.06	32.99 ± 0.10	51.63 ± 0.17
LeCam-GAN [40]	33.16	24.93	10.16	34.18	54.88
+ KD-DLGAN (Ours)	29.38 ± 0.15	19.65 ± 0.17	8.41 ± 0.05	31.89 ± 0.09	50.22 ± 0.16
InsGen [44]	45.85	27.48	12.13	41.33	55.12
+ KD-DLGAN (Ours)	38.28 ± 0.25	22.16 ± 0.12	9.51 ± 0.07	32.39 ± 0.08	50.13 ± 0.12
APA [19]	43.75	28.49	12.34	39.13	54.15
+ KD-DLGAN (Ours)	34.68 ± 0.21	23.14 ± 0.14	8.70 ± 0.05	31.77 ± 0.09	51.23 ± 0.13
ADA [21]	45.69	26.62	12.90	40.77	56.83
+ KD-DLGAN (Ours)	31.78 ± 0.22	19.76 ± 0.11	8.85 ± 0.05	32.81 ± 0.10	51.12 ± 0.15

Proposed Method: KD-DLGAN

- Synthesis Results (100 Shot and AFHQ)



Proposed Method: KD-DLGAN

- Synthesis Results (CIFAR)

Method	CIFAR-10			CIFAR-100		
	100% Data	20% Data	10% Data	100% Data	20% Data	10% Data
DA [53] + KD (CLIP [36])	8.70 ± 0.02	13.70 ± 0.08	22.03 ± 0.07	11.74 ± 0.02	21.76 ± 0.06	33.93 ± 0.09
DA [53] (Baseline)	8.75 ± 0.03	14.53 ± 0.10	23.34 ± 0.09	11.99 ± 0.02	22.55 ± 0.06	35.39 ± 0.08
+ KD-DLGAN (Ours)	8.42 ± 0.01	11.01 ± 0.07	14.20 ± 0.06	10.28 ± 0.03	15.60 ± 0.08	18.03 ± 0.11
APA [19]	8.28 ± 0.02	15.31 ± 0.04	25.98 ± 0.06	11.42 ± 0.04	23.50 ± 0.06	45.79 ± 0.15
+ KD-DLGAN (Ours)	8.26 ± 0.02	11.15 ± 0.06	13.86 ± 0.07	10.23 ± 0.02	19.22 ± 0.07	27.11 ± 0.10
LeCam-GAN [40]	8.46 ± 0.06	14.55 ± 0.08	16.69 ± 0.02	11.20 ± 0.09	22.45 ± 0.09	27.28 ± 0.05
+ KD-DLGAN (Ours)	8.19 ± 0.01	11.45 ± 0.07	13.22 ± 0.03	10.12 ± 0.03	18.70 ± 0.05	22.40 ± 0.06
ADA [21]	8.99 ± 0.03	19.87 ± 0.09	30.58 ± 0.11	12.22 ± 0.02	22.65 ± 0.10	27.08 ± 0.15
+ KD-DLGAN (Ours)	8.46 ± 0.02	14.12 ± 0.10	16.88 ± 0.08	10.48 ± 0.04	19.26 ± 0.06	20.62 ± 0.09

Proposed Method: KD-DLGAN

- Synthesis Results (ImageNet)

Method	10% training data		5% training data		2.5% training data	
	IS \uparrow	FID \downarrow	IS \uparrow	FID \downarrow	IS \uparrow	FID \downarrow
DA [53] + KD (CLIP [36])	13.29 \pm 0.50	26.58 \pm 0.21	11.63 \pm 0.29	38.11 \pm 0.33	9.43 \pm 0.25	57.95 \pm 0.41
DA [53] (Baseline)	12.76 \pm 0.34	32.82 \pm 0.18	9.63 \pm 0.21	56.75 \pm 0.35	8.17 \pm 0.28	63.49 \pm 0.51
+ KD-DLGAN (Ours)	14.25 \pm 0.66	19.99 \pm 0.11	12.71 \pm 0.34	24.70 \pm 0.14	13.45 \pm 0.51	30.27 \pm 0.16
LeCam-GAN [40]	11.59 \pm 0.44	30.32 \pm 0.24	10.53 \pm 0.22	39.33 \pm 0.27	9.99 \pm 0.26	54.55 \pm 0.46
+ KD-DLGAN (Ours)	13.98 \pm 0.23	22.12 \pm 0.12	13.86 \pm 0.45	23.85 \pm 0.21	13.22 \pm 0.44	31.33 \pm 0.15
ADA	12.67 \pm 0.31	31.89 \pm 0.17	9.44 \pm 0.25	43.21 \pm 0.37	8.54 \pm 0.26	56.83 \pm 0.48
+ KD-DLGAN (Ours)	14.14 \pm 0.32	20.32 \pm 0.10	14.06 \pm 0.39	22.35 \pm 0.11	14.65 \pm 0.47	28.79 \pm 0.14

Proposed Method: KD-DLGAN

- Ablation Study

Method	AGKD	CGKD	CIFAR-10		100-shot	
			20% data	10% data	Obama	Grumpy Cat
DA [53] (Baseline)			14.53	23.34	46.87	27.08
	✓		12.97 ± 0.08	15.85 ± 0.06	35.51 ± 0.25	23.24 ± 0.16
		✓	12.77 ± 0.08	18.66 ± 0.09	36.18 ± 0.22	23.17 ± 0.11
Ours	✓	✓	11.01 ± 0.07	14.20 ± 0.06	31.54 ± 0.27	20.13 ± 0.13

Proposed Method: KD-DLGAN

- Discussion 1

Method	CIFAR-10 10% data	CIFAR-100 10% data
DA [53] (Baseline)	23.34 ± 0.09	35.39 ± 0.08
Fitnets [37]	22.03 ± 0.07	33.93 ± 0.09
Label Distillation [17]	20.46 ± 0.10	34.14 ± 0.11
PKD [35]	21.34 ± 0.08	32.15 ± 0.13
SPKD [41]	19.11 ± 0.07	31.97 ± 0.10
KD-DLGAN (Ours)	14.20 ± 0.06	18.03 ± 0.11



Proposed Method: KD-DLGAN

- Discussion 2

Method	CIFAR-10 10% data	CIFAR-100 10% data
DA [53] (Baseline)	23.34 ± 0.09	35.39 ± 0.08
+ TCL [46]	14.98 ± 0.09	18.43 ± 0.12
+ BLIP [26]	15.74 ± 0.10	18.88 ± 0.11
+ CLIP [36] (Ours)	14.20 ± 0.06	18.03 ± 0.11



Proposed Method: KD-DLGAN

- Discussion 3

Method	CIFAR-10 10% data	CIFAR-100 10% data
DA [53] (Baseline)	23.34 \pm 0.09	35.39 \pm 0.08
Vision-aided GAN [25]	16.24 \pm 0.08	19.11 \pm 0.10
KD-DLGAN (Ours)	14.20 \pm 0.06	18.03 \pm 0.11



Thank you for your attention

