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MatchingGAN: Matching-Based Few-Shot Image Generation

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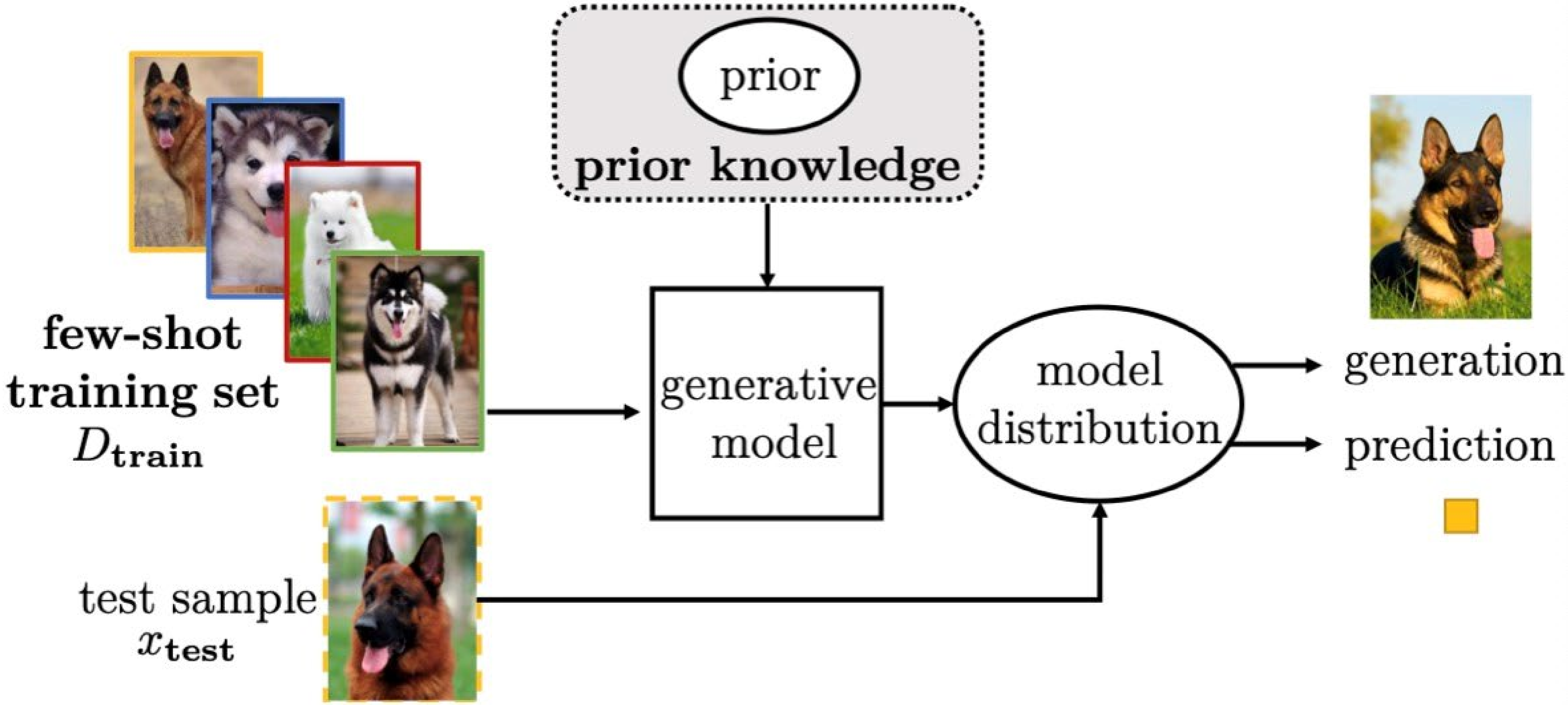
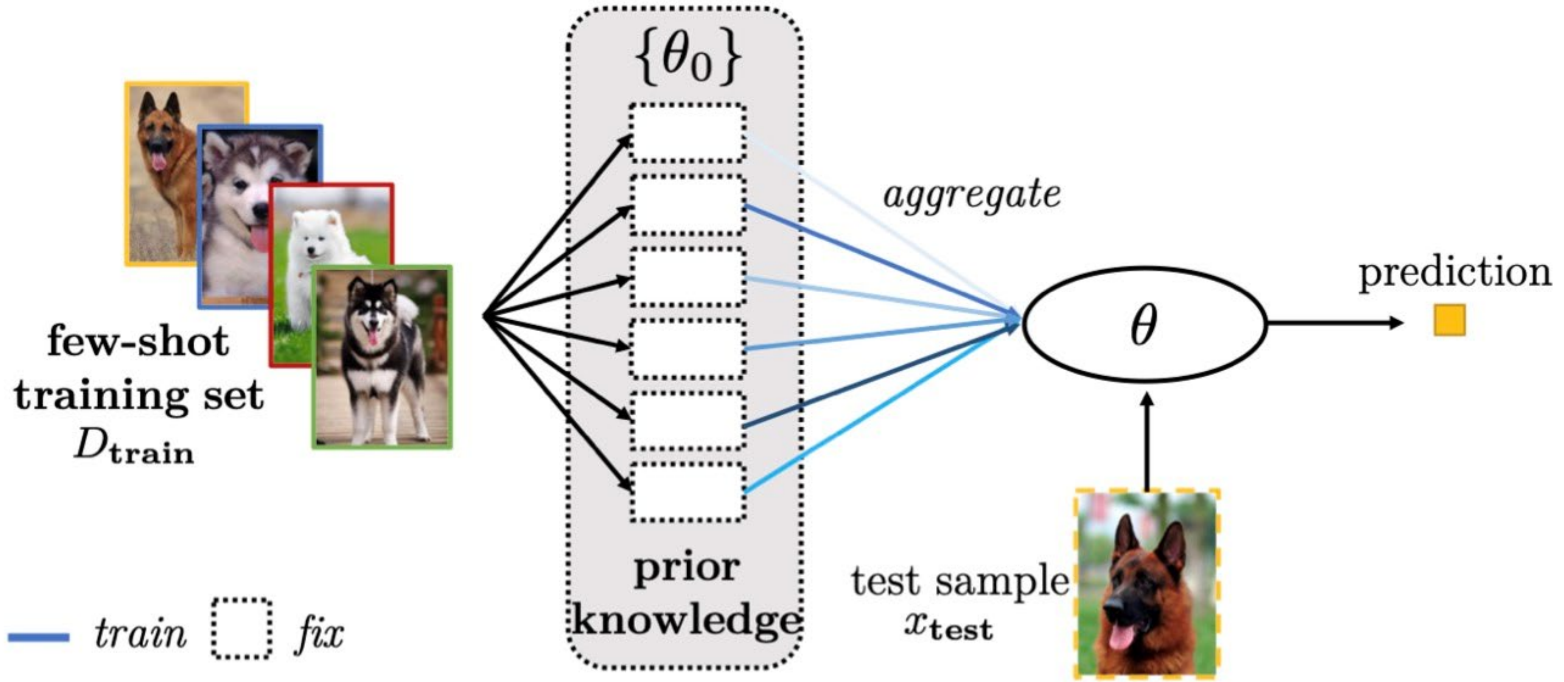
Few-shot Learning



Metric-based Few-shot Learning



The model can be used at testing phase without fine-tuning

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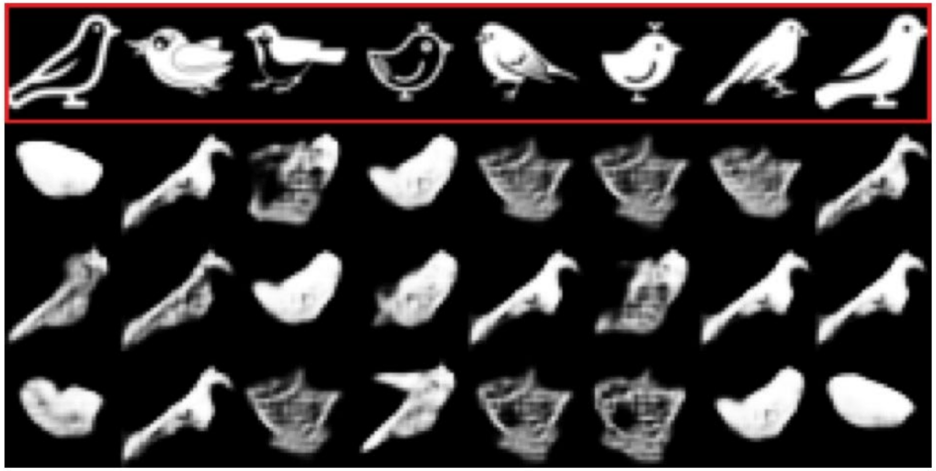
Few-shot Image Generation

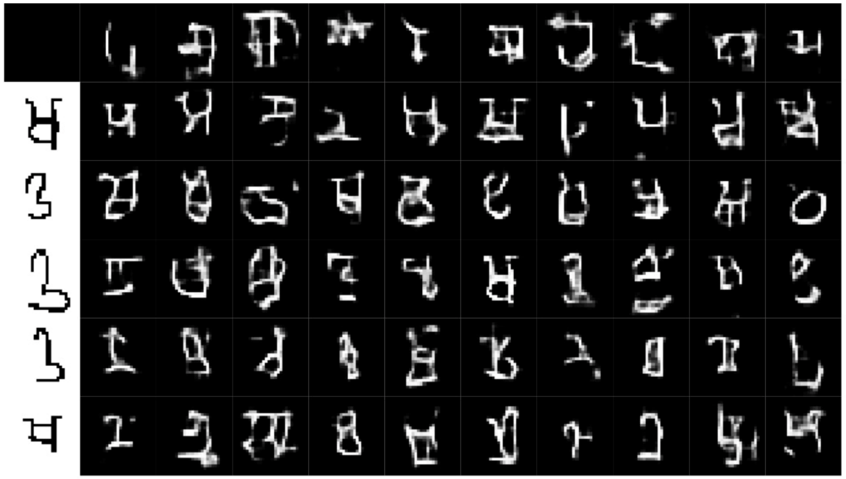
- Extensive training samples is expensive, difficulty in quick adaptation
- Few shot image generation can augment training dataset, facilitate downstream tasks like few-shot classification

The Issues in Existing Few-shot Image Generation

➤ The quality of generated images is poor



Generated images are vague



Generated images are unreasonable

The Issues in Existing Few-shot Image Generation

- The diversity of generated images is limited

Conditional images

Generated images

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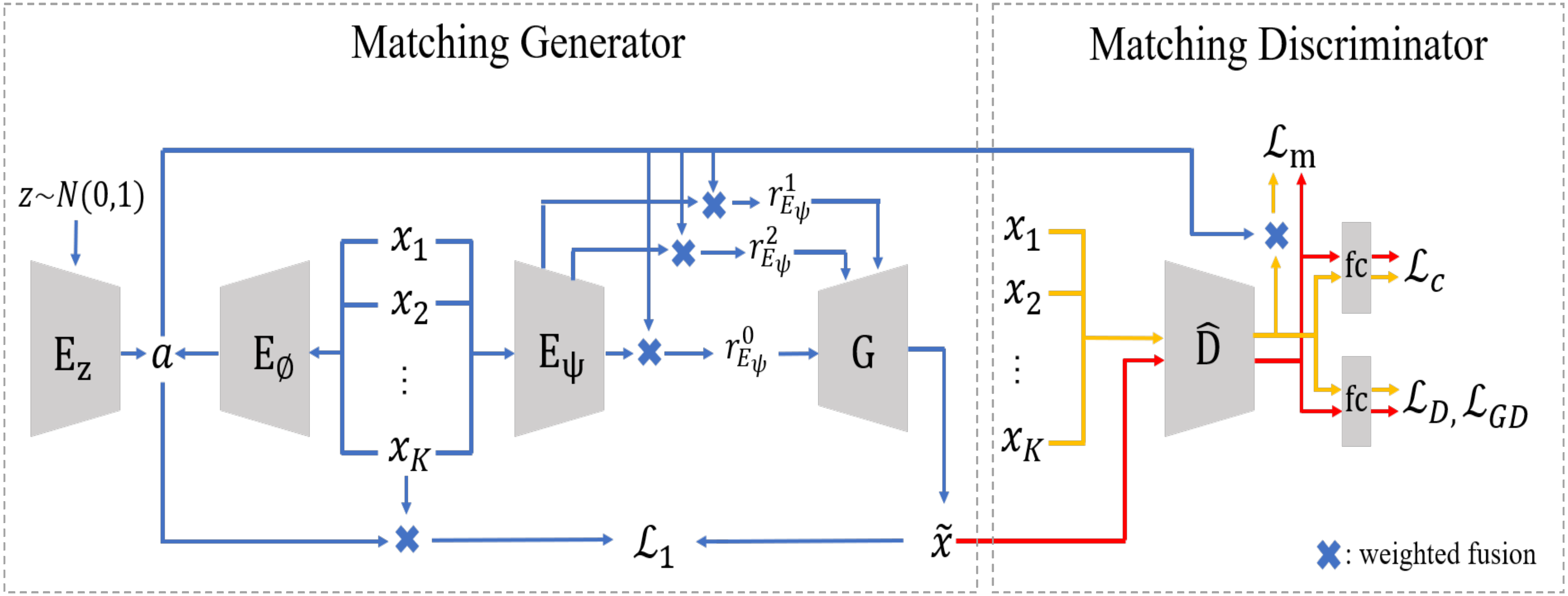
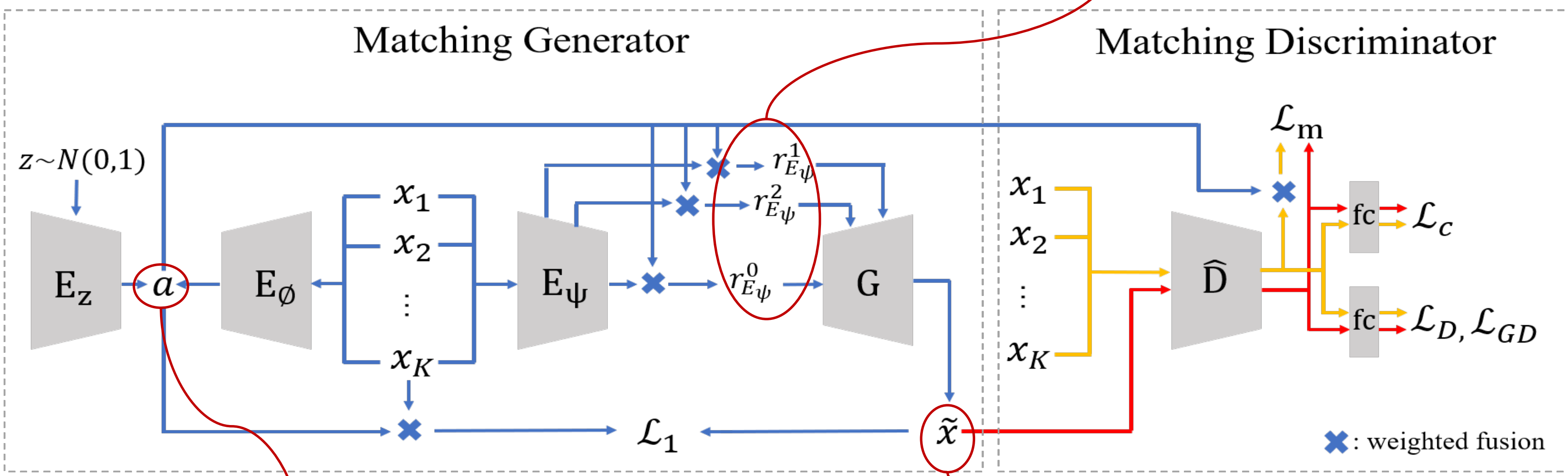
Framework

Combining matching procedure with generative adversarial network



Matching Procedure

$$\boldsymbol{r}_{E_\psi}^{j} = \sum_{i=1}^{K} \mathrm{a}(E_z(\boldsymbol{z}), E_\phi(\boldsymbol{x}_i)) E_\psi^{j}(\boldsymbol{x}_i), \ \ j = 0, \ldots, L$$

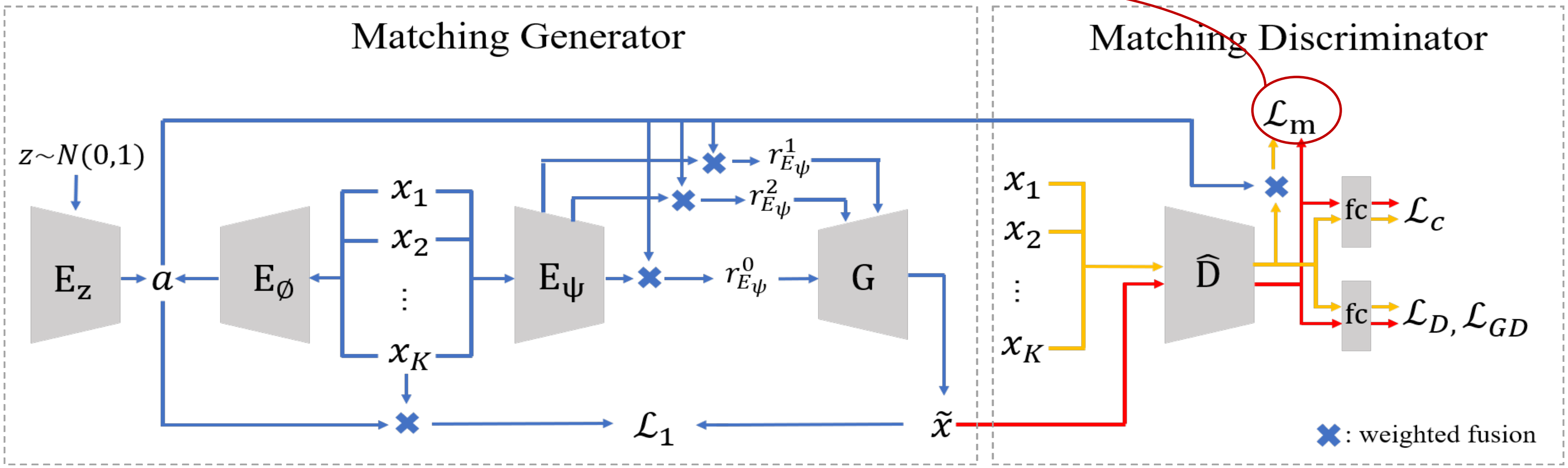


$$\mathrm{a}(E_z(\boldsymbol{z}), E_\phi(\boldsymbol{x}_i)) = \frac{e^{\cos(E_z(\boldsymbol{z}), E_\phi(\boldsymbol{x}_i))}}{\sum_{i=1}^{K} e^{\cos(E_z(\boldsymbol{z}), E_\phi(\boldsymbol{x}_i))}}$$

$$\tilde{\boldsymbol{x}} = G(\boldsymbol{r}_{E_\psi}^{0}, \boldsymbol{r}_{E_\psi}^{1}, \ldots, \boldsymbol{r}_{E_\psi}^{L})$$

Matching Procedure

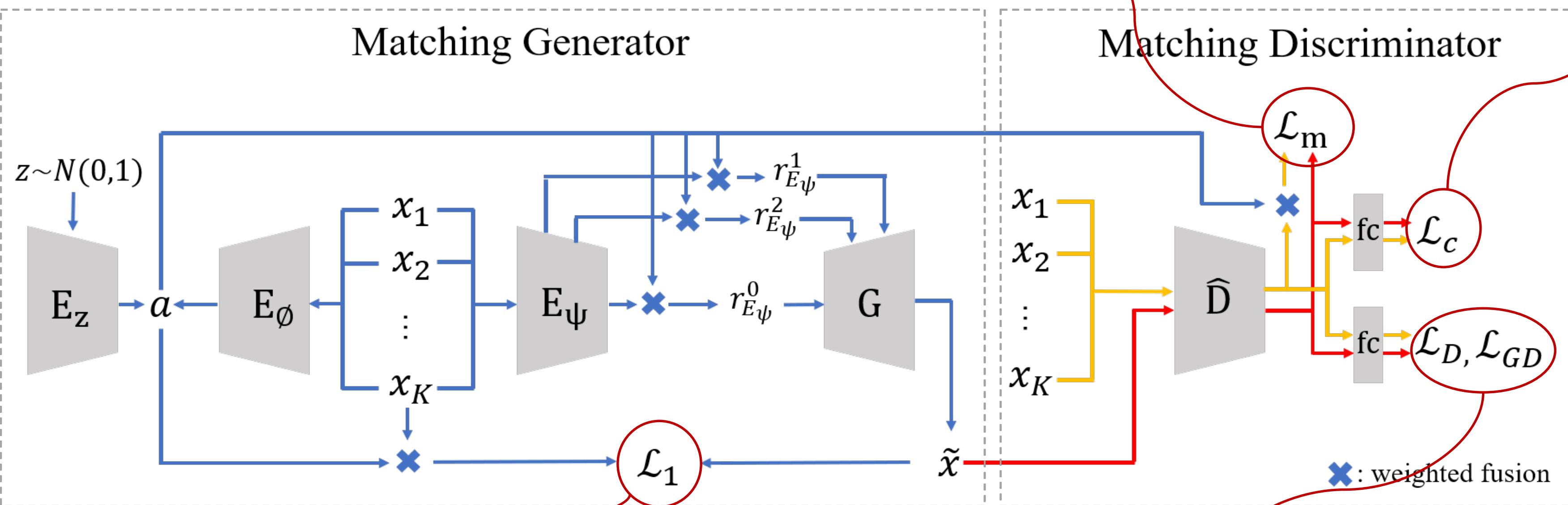
$$\mathcal{L}_m = \|\sum_{i=1}^{K} \mathrm{a}(E_z(\boldsymbol{z}), E_\phi(\boldsymbol{x}_i))\hat{D}(\boldsymbol{x}_i) - \hat{D}(\tilde{\boldsymbol{x}})\|_1$$



Optimization

$$\mathcal{L}_m = ||\sum_{i=1}^{K} \mathrm{a}(E_z(\boldsymbol{z}), E_\phi(\boldsymbol{x}_i))\hat{D}(\boldsymbol{x}_i) - \hat{D}(\tilde{\boldsymbol{x}})||_1$$

$$\mathcal{L}_c = -\log p(c(\boldsymbol{x})|\boldsymbol{x})$$



$$\mathcal{L}_1 = \sum_{i=1}^{K} \mathrm{a}(E_z(\boldsymbol{z}), E_\phi(\boldsymbol{x}_i))||\boldsymbol{x}_i - \tilde{\boldsymbol{x}}||_1$$

$$\mathcal{L}_D = \mathbb{E}_{\tilde{\boldsymbol{x}}}[\max(0, 1 + \mathrm{D}(\tilde{\boldsymbol{x}}))] + \mathbb{E}_{\boldsymbol{x}_i}[\max(0, 1 - \mathrm{D}(\boldsymbol{x}_i))]$$

$$\mathcal{L}_{GD} = -\mathbb{E}_{\tilde{\boldsymbol{x}}}[\mathrm{D}(\tilde{\boldsymbol{x}})]$$

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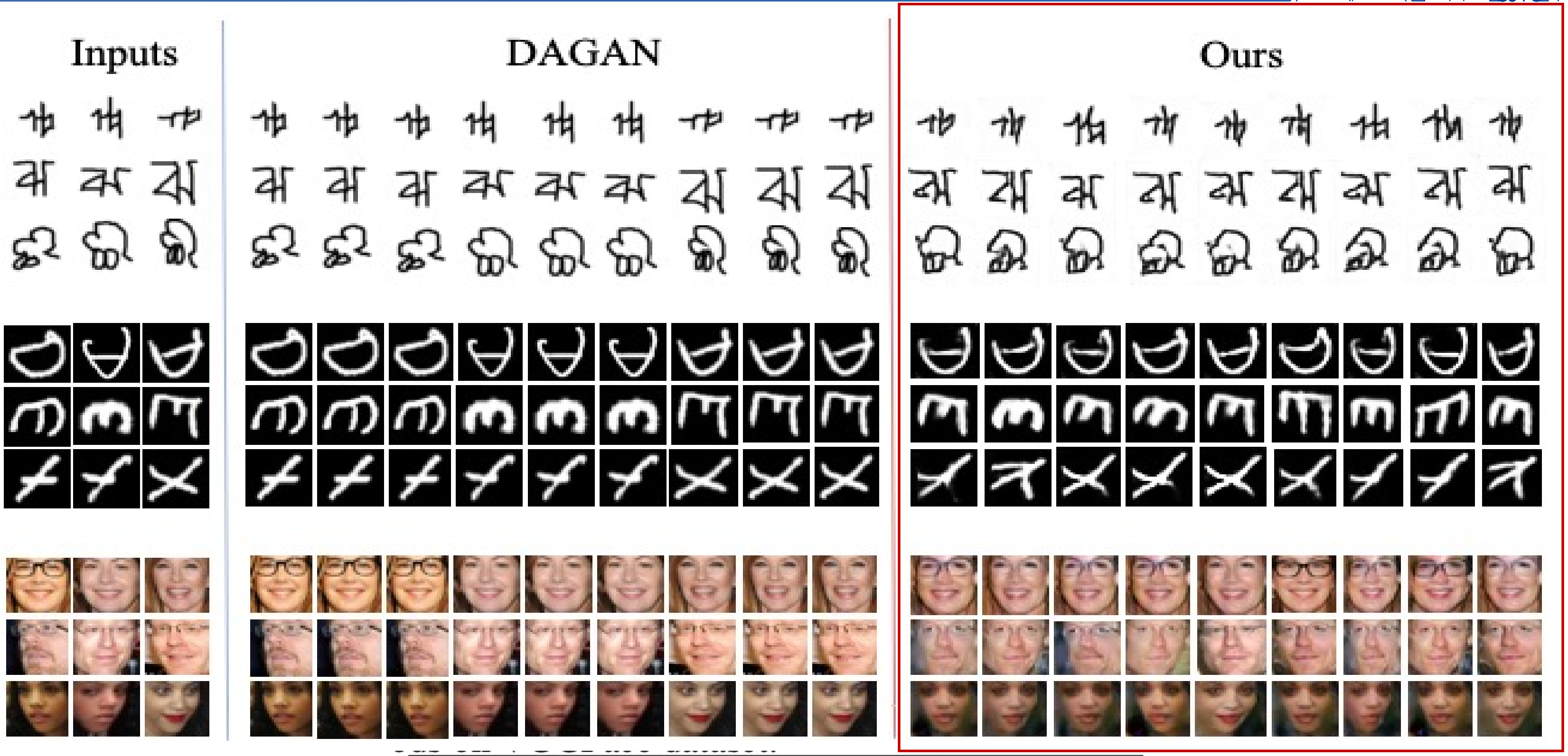
Visualization Results



Methods	FID (↓)	IS (↑)
FIGR [3]	154.21	5.19
GMN [4]	201.12	6.38
DAGAN [6]	121.43	4.12
Ours	108.56	8.32

Classification in Low-data Setting

Method	Dataset	Accuracy		
		5	10	15
Standard	Omniglot	66.22	81.87	83.31
FIGR [3]	Omniglot	69.23	83.12	84.89
GMN [4]	Omniglot	67.74	84.19	85.12
DAGAN [6]	Omniglot	88.81	89.32	95.38
Ours	Omniglot	89.03	90.92	96.29
Standard	EMNIST	83.64	88.64	91.14
FIGR [3]	EMNIST	85.91	90.08	92.18
GMN [4]	EMNIST	84.56	91.21	92.09
DAGAN [6]	EMNIST	87.45	94.18	95.58
Ours	EMNIST	91.75	95.91	96.29
Standard	VGGFace	8.82	20.29	39.12
FIGR [3]	VGGFace	6.12	18.84	32.13
GMN [4]	VGGFace	5.23	15.61	35.48
DAGAN [6]	VGGFace	19.23	35.12	44.36
Ours	VGGFace	21.12	40.95	50.12

Classification in Few-shot Setting

Methods	Dataset	5-way 5-shot	10-way 5-shot
MatchingNets [11]	Omniglot	98.70	98.91
MAML [20]	Omniglot	99.90	99.13
RelationNets [21]	Omniglot	99.80	99.22
MTL [22]	Omniglot	99.85	99.35
DN4 [23]	Omniglot	99.83	99.29
Ours	Omniglot	99.93	99.42
MatchingNets [11]	VGGFace	60.01	48.67
MAML [20]	VGGFace	61.09	47.89
RelationNets [21]	VGGFace	60.93	49.12
MTL [22]	VGGFace	63.67	51.94
DN4 [23]	VGGFace	62.89	51.58
Ours	VGGFace	65.12	53.21

Ablation Study

setting	accuracy	FID (↓)	IS (↑)
$\lambda_r = 0.01$	35.62	112.16	7.89
$\lambda_r = 0.1$	40.95	108.56	8.32
$\lambda_r = 1$	33.89	107.16	9.17
$\lambda_r = 10$	30.12	106.12	11.04
$\lambda_m = 1$	40.95	108.56	8.32
$\lambda_m = 0$	28.98	111.4	7.56
matching coefficient	40.95	108.56	8.32
random coefficient	38.12	110.98	7.92
1 connection	38.67	113.21	7.09
2 connection	40.95	108.56	8.32
3 connection	34.12	106.12	9.14

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Thanks for watching!

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