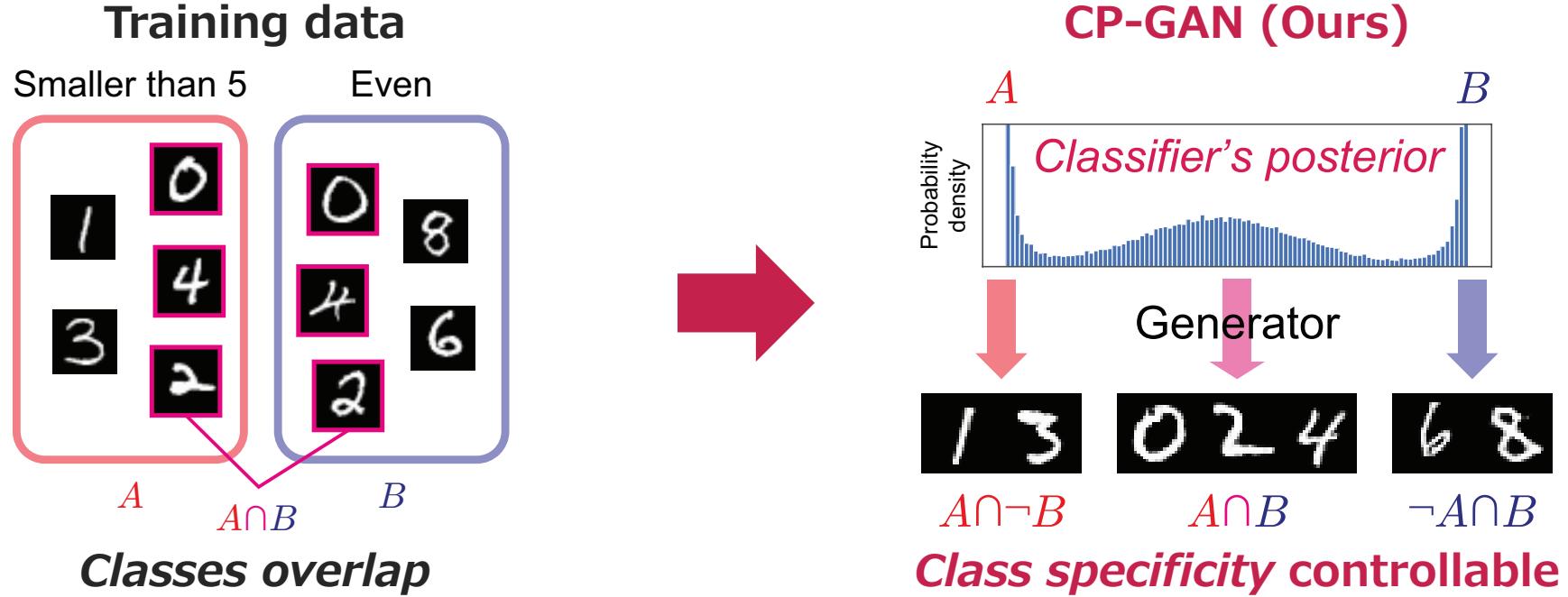


Class-Distinct and Class-Mutual Image Generation with GANs



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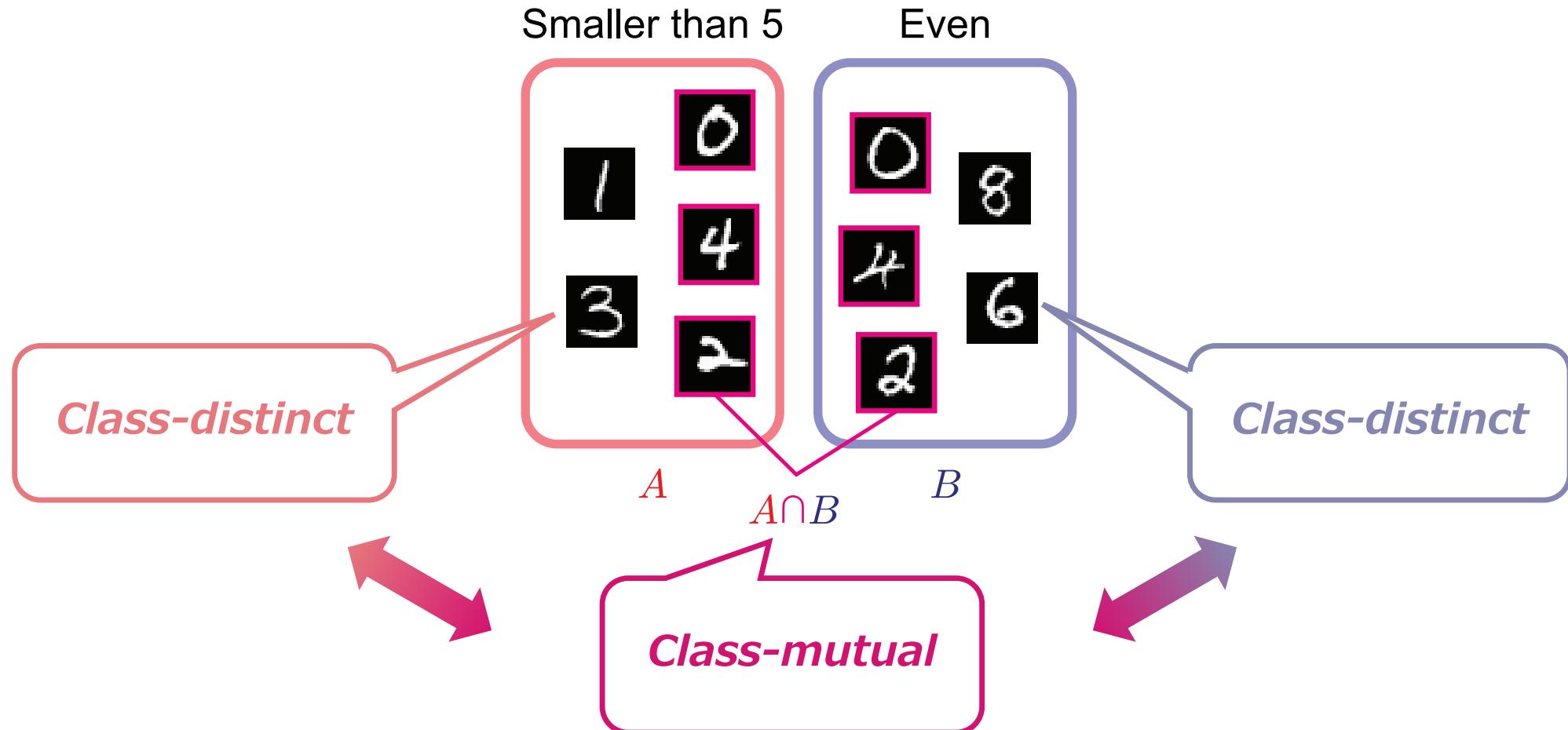
Code



Objective: Class-distinct and class-mutual image generation

Our goal is to construct a **class-distinct** and **class-mutual** image generator

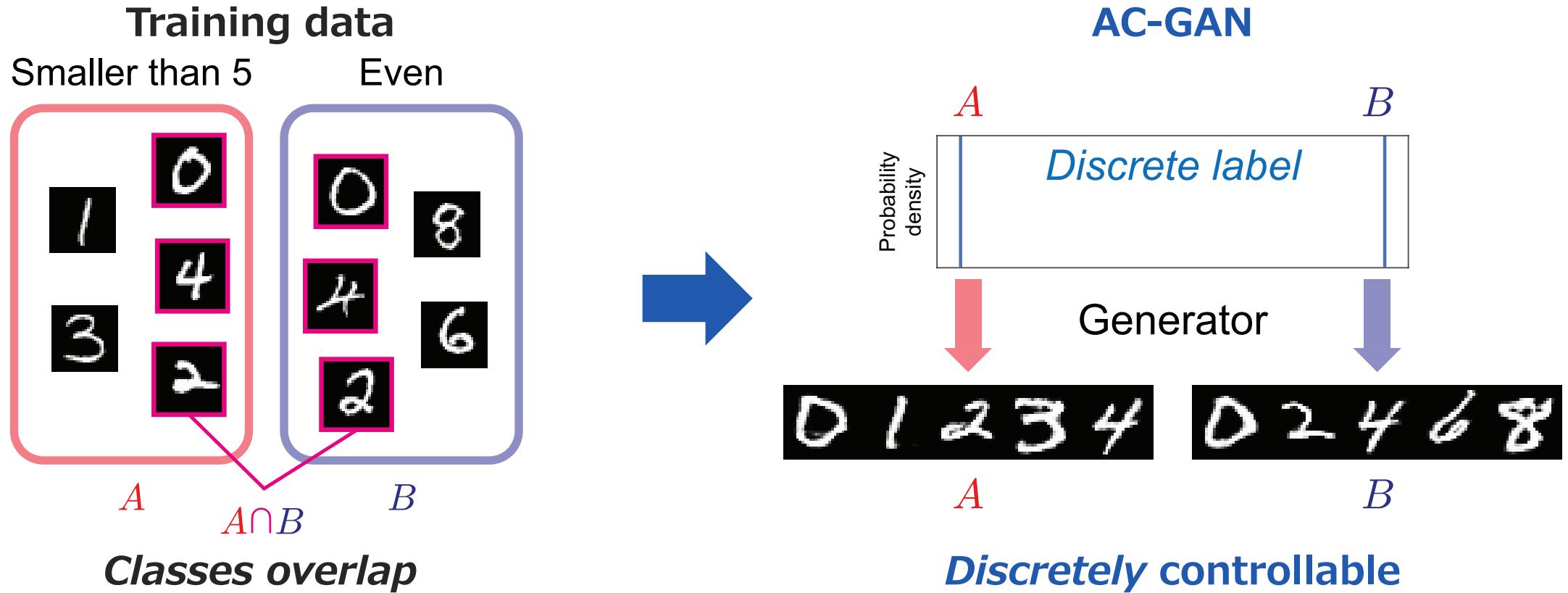
- Generates **class-distinct** (A or B) and **class-mutual** ($A \cap B$) images **selectively**, when given **class-overlapping data**.



Challenge: Limitations of naïve conditional generative models

Naïve conditional generative models (e.g., AC-GAN [1] and cGAN [2, 3])

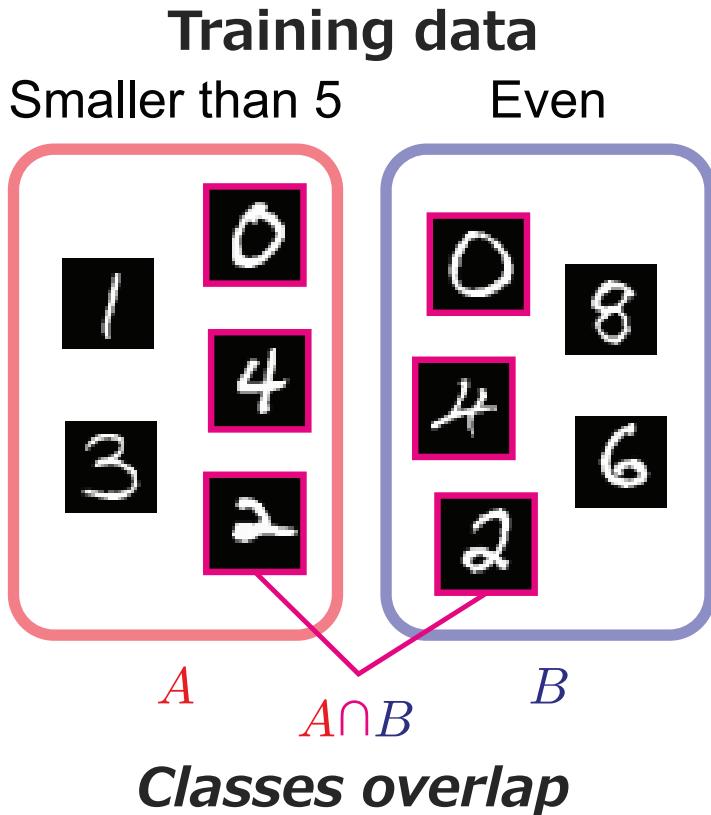
- Optimized conditioned on *discrete labels*.
- Generate data of each class *separately* even if *classes overlap*.



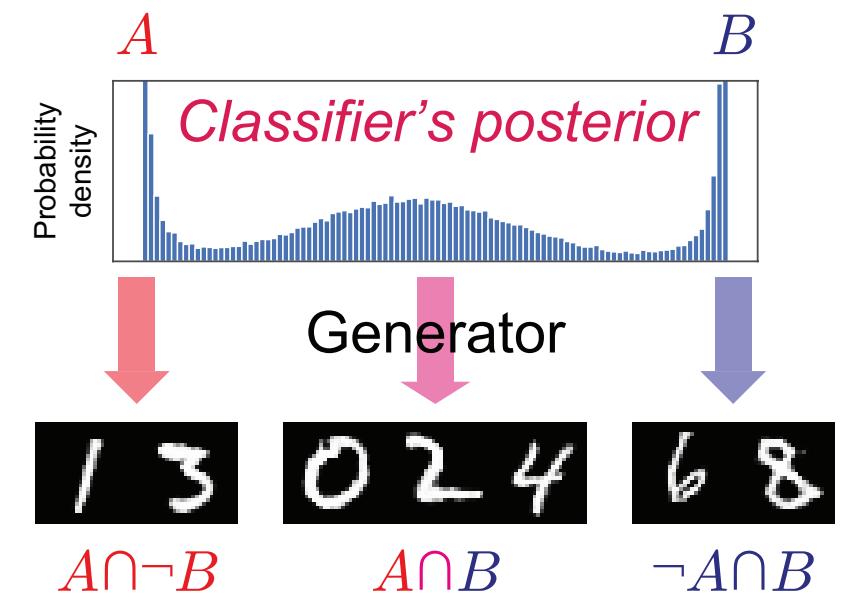
Contribution: Proposal of classifier's posterior GAN

We propose **classifier's posterior GAN (CP-GAN)**

- Represents ***between-class relationships*** in the generator input.
- Generates an image ***selectively*** conditioned on the ***class-specificity***.



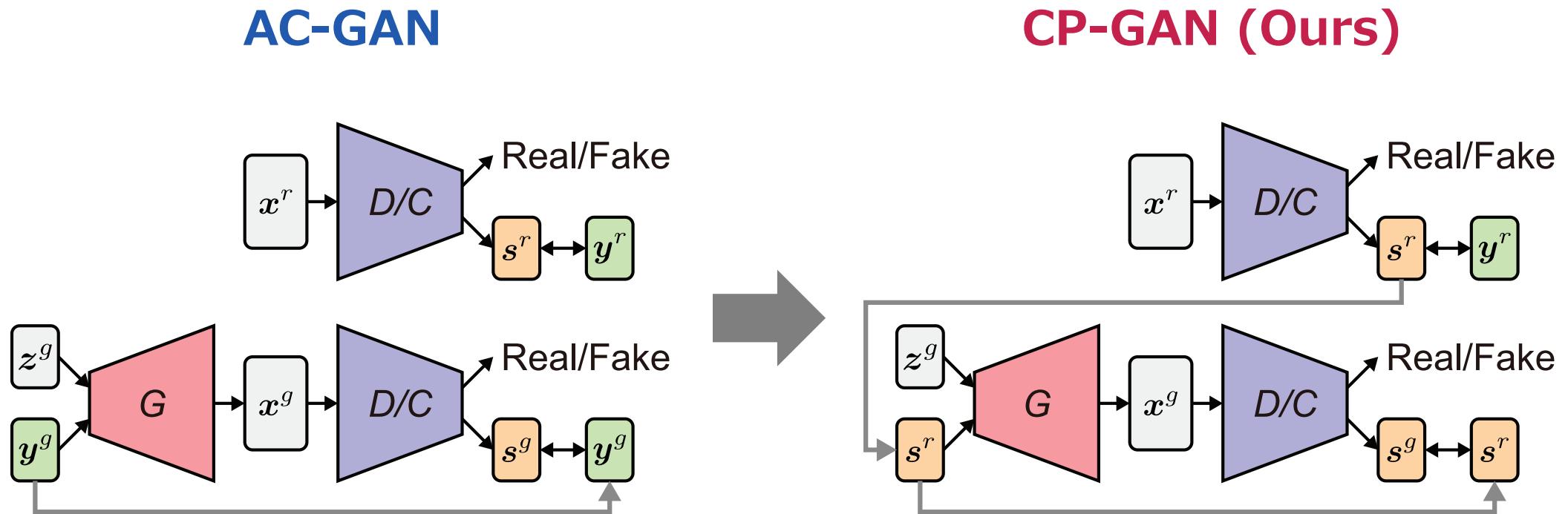
CP-GAN (Ours)



Class-specificity controllable

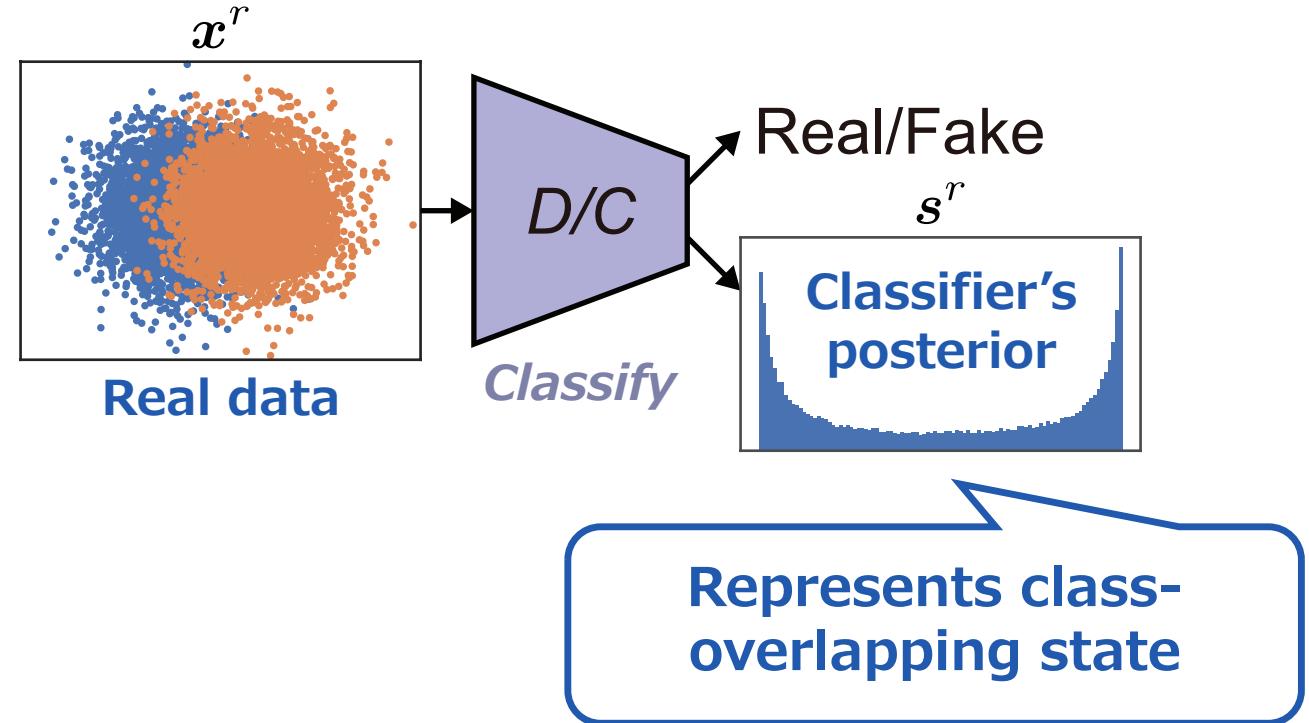
Main idea: Redesign generator input and objective of AC-GAN

We redesign the **generator input** and the **objective function** of AC-GAN.



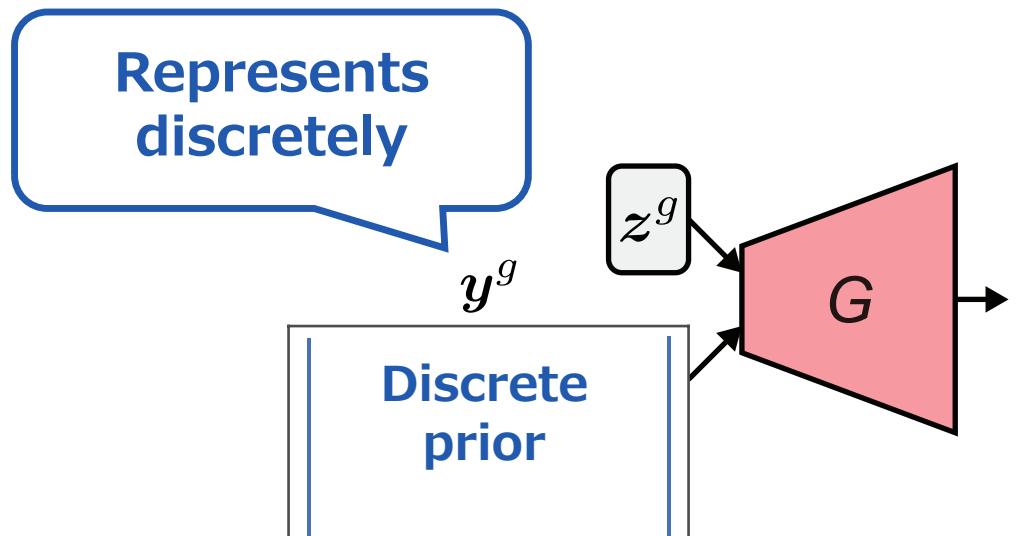
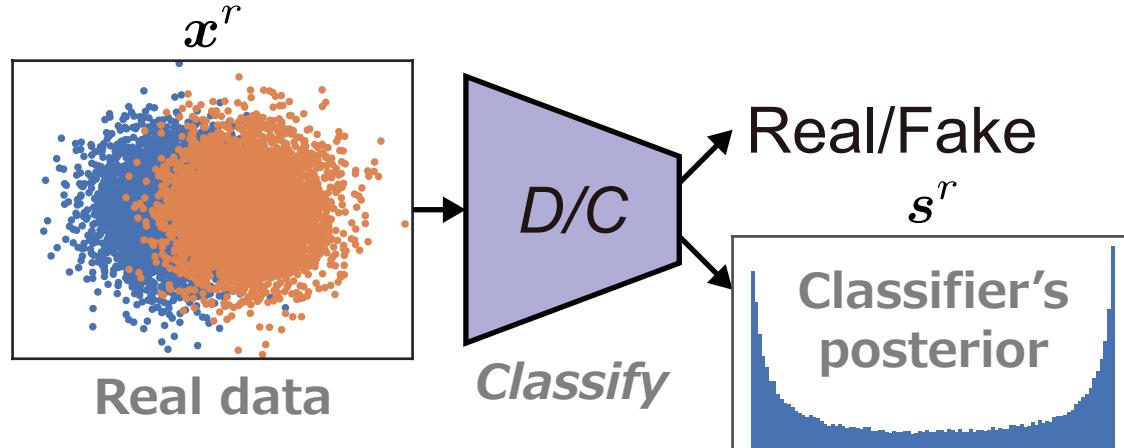
Baseline: AC-GAN

Training data: Two-class Gaussian distributions with class overlapping



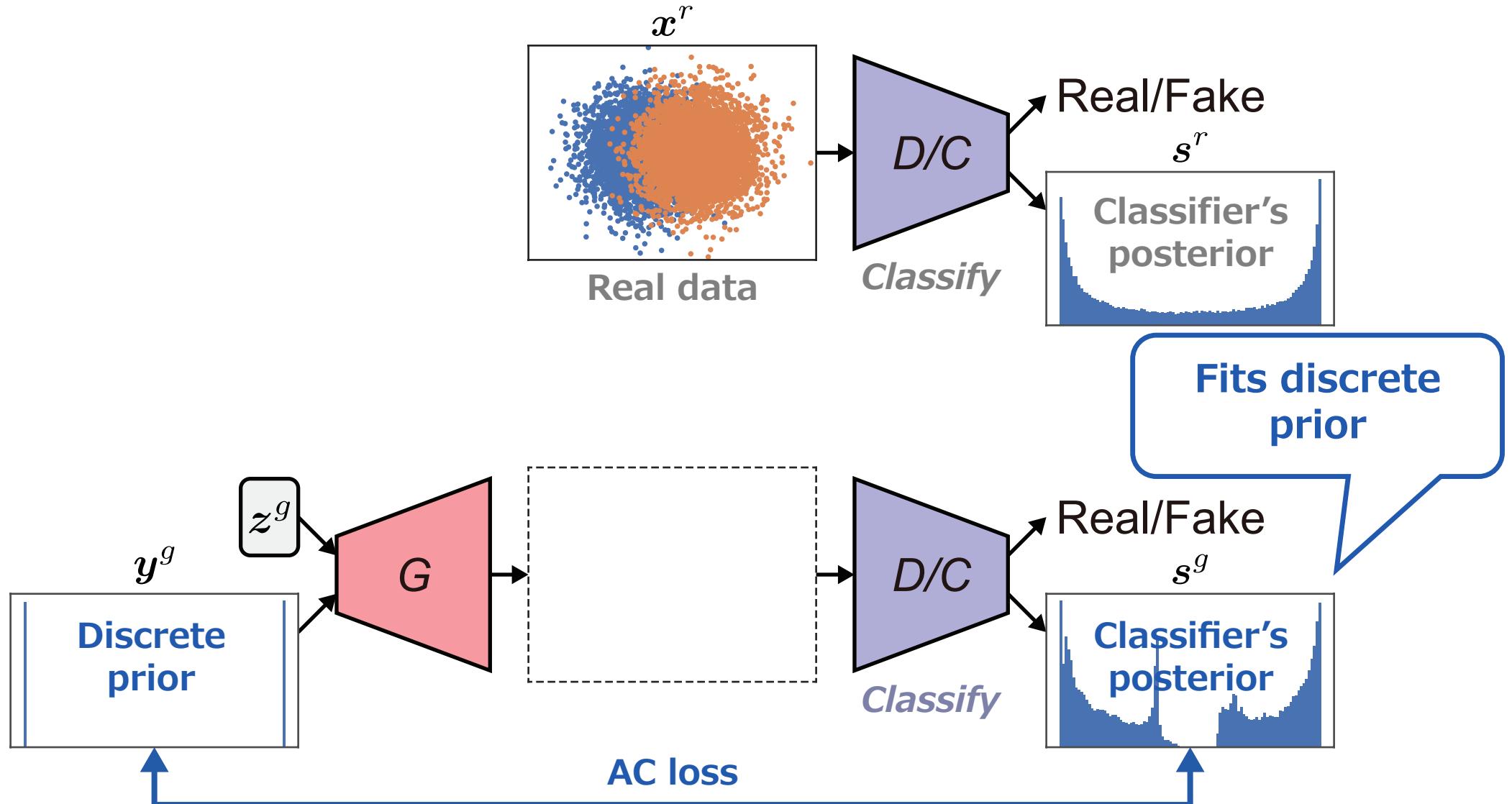
Baseline: AC-GAN

Training data: Two-class Gaussian distributions with class overlapping



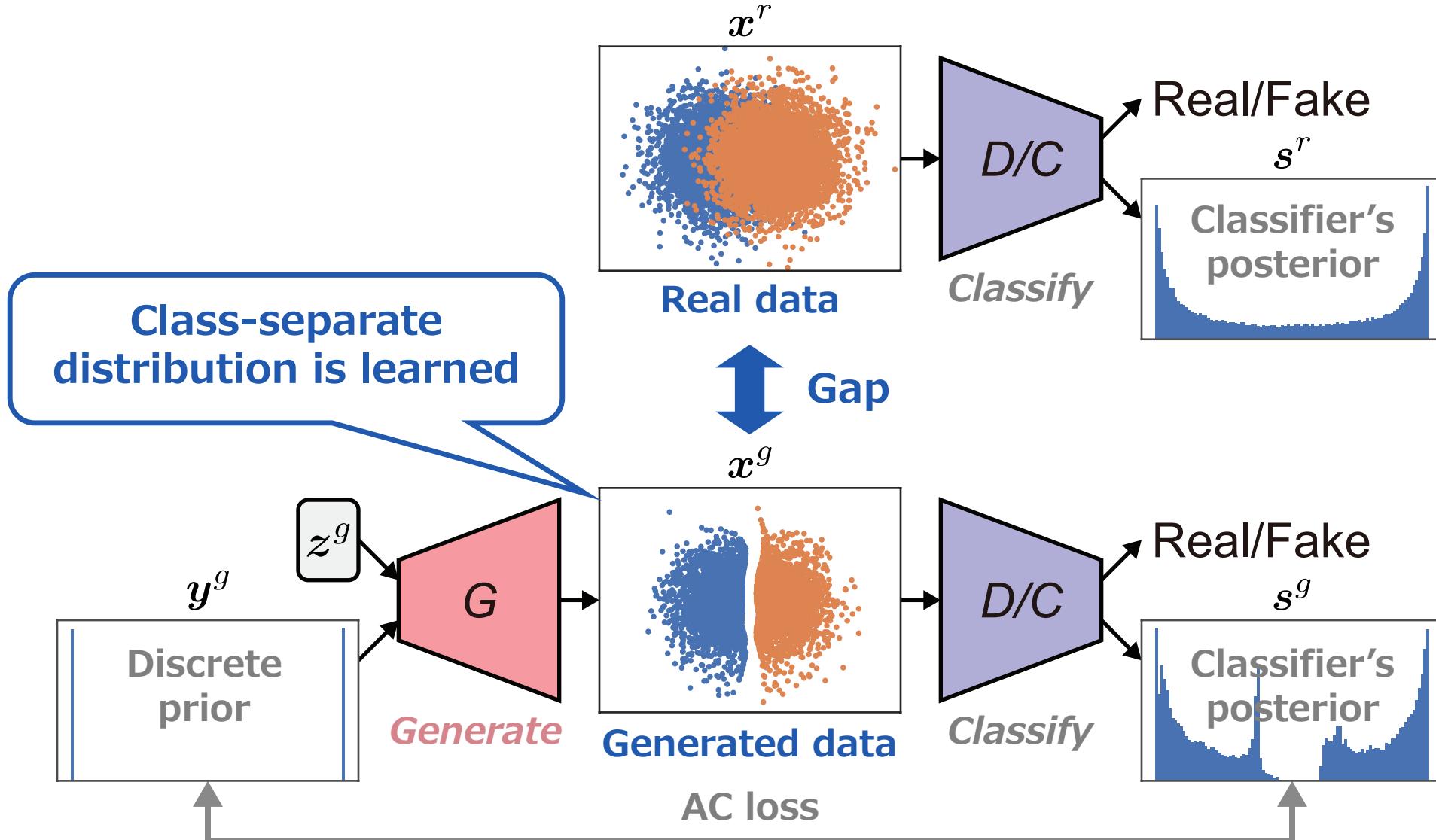
Baseline: AC-GAN

Training data: Two-class Gaussian distributions with class overlapping



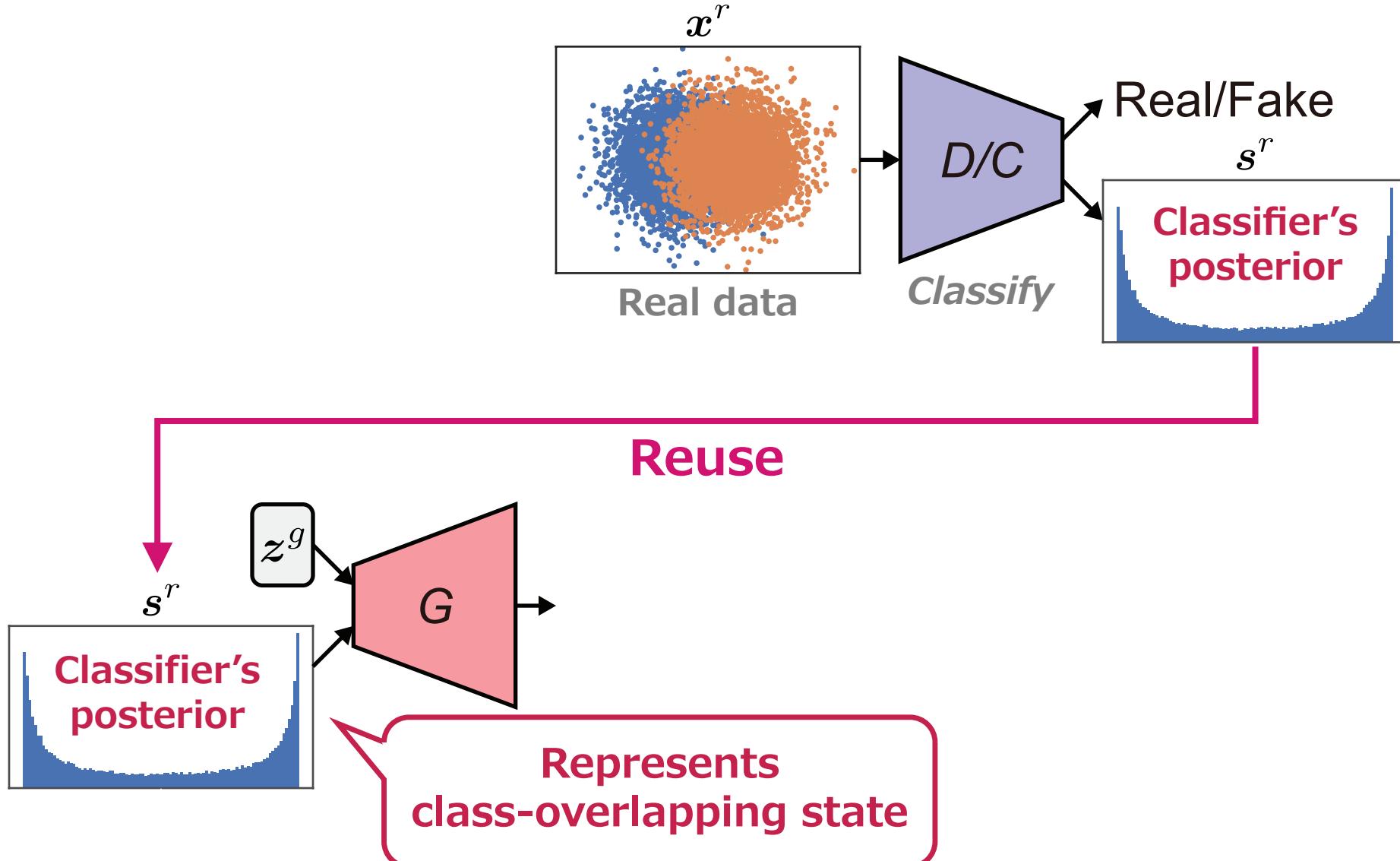
Baseline: AC-GAN

Training data: Two-class Gaussian distributions with class overlapping



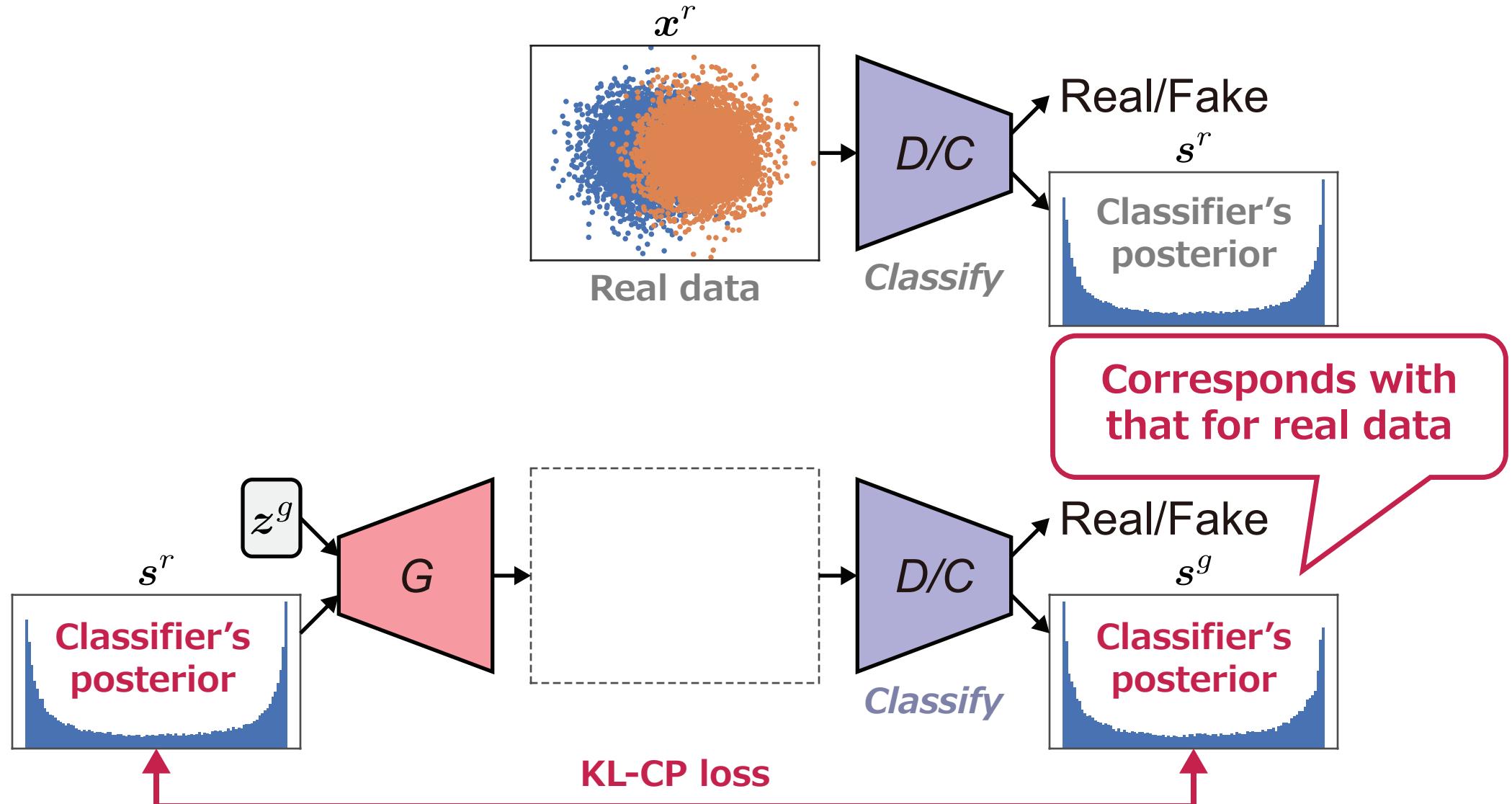
Proposal: CP-GAN

Training data: Two-class Gaussian distributions with class overlapping



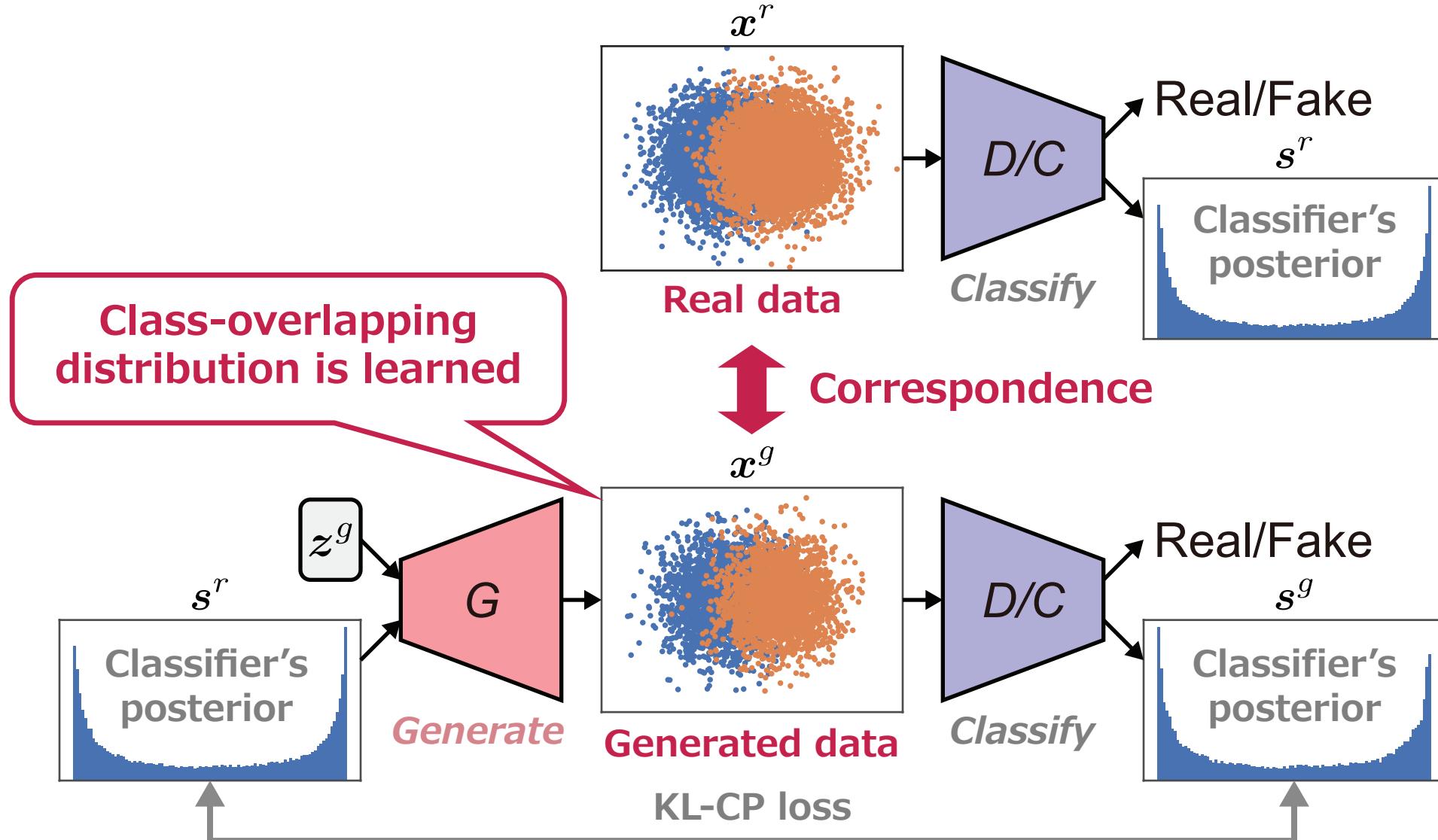
Proposal: CP-GAN

Training data: Two-class Gaussian distributions with class overlapping



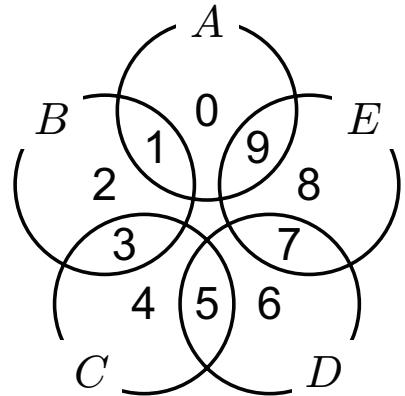
Proposal: CP-GAN

Training data: Two-class Gaussian distributions with class overlapping



Experiments I: Controlled class-overlapping data

CIFAR-10 [4]: We made the class overlapping state in a *controlled* manner.



$$\begin{aligned}\{9, 0, 1\} &\in A \\ \{1, 2, 3\} &\in B \\ \{3, 4, 5\} &\in C \\ \{5, 6, 7\} &\in D \\ \{7, 8, 9\} &\in E\end{aligned}$$

0: Airplane	5: Dog
1: Automobile	6: Frog
2: Bird	7: Horse
3: Cat	8: Ship
4: Deer	9: Truck

Expected states	A	$A \cap B$	B	$B \cap C$	C	$C \cap D$	D	$D \cap E$	E	$E \cap A$
AC-GAN [1]										
cGAN [3]										
CFGAN [5]										
CP-GAN										

- ✓ Achieves the **best FID** [6].
- ✓ Succeeds in generating **class-distinct and class-mutual images selectively**.

[1] Odena et al. ICML 2017. [3] Miyato & Koyama. ICLR 2018. [4] Krizhevsky. 2009.

[5] Kaneko et al. CVPR 2017. [6] Heusel et al. NIPS 2017.

Experiments II: Real-world class-overlapping data

Clothing1M [7]: Includes *real-world* class-overlapping data.



Expected states	T-Shirt	Shirt	Knitwear	Chiffon	Sweater	Hoodie	Windbreaker	Jacket	Suit	Down Coat	Shawl	Dress	Vest	Underwear
AC-GAN [1]														
	49.5	49.2	23.7	52.4	5.9	27.0	23.8	70.4	81.3	60.5	35.0	60.7	54.3	54.7
cGAN [3]														
	44.8	48.0	25.7	37.6	34.0	35.8	52.5	64.8	73.1	44.9	74.9	52.6	41.8	62.4
CP-GAN														
	51.4	60.2	42.2	55.7	33.6	48.6	86.3	67.9	92.7	67.6	91.9	74.2	70.6	68.1

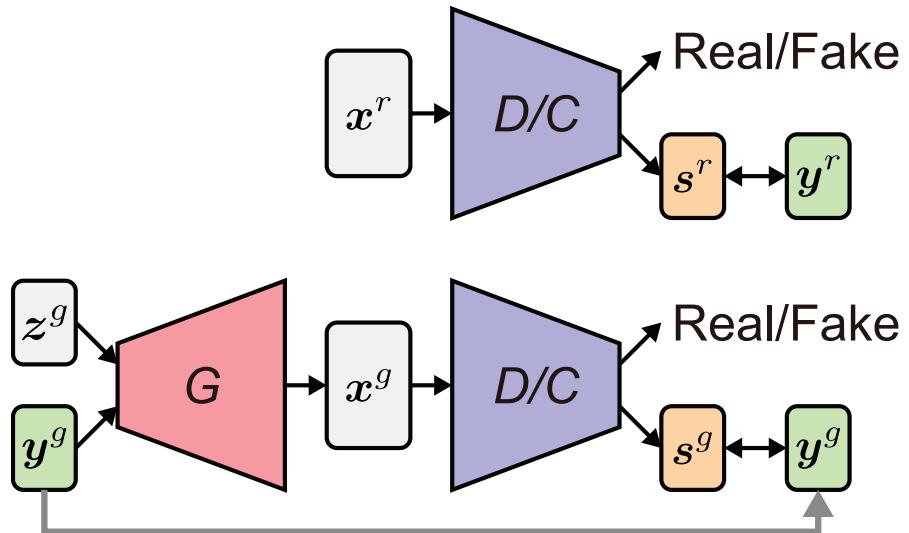
- ✓ Achieves the **best FID** [6].
- ✓ Succeeds in generating **class-distinct images selectively**.

Thank you!

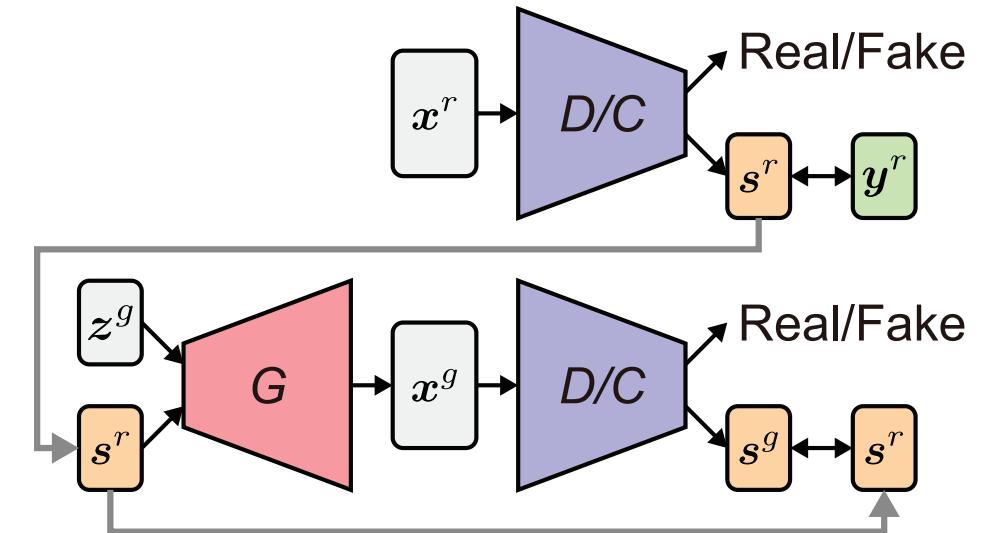
Our code is publicly available at
<https://github.com/takuhirok/CP-GAN/>



AC-GAN



CP-GAN (Ours)



Class-Distinct and Class-Mutual Image Generation with GANs