Improving GANs for Long-Tailed Data through Group Spectral Regularization

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Motivation

Class Distribution   BigGAN [2] (LeCam [31] + DiffAug [39])

Tail Classes
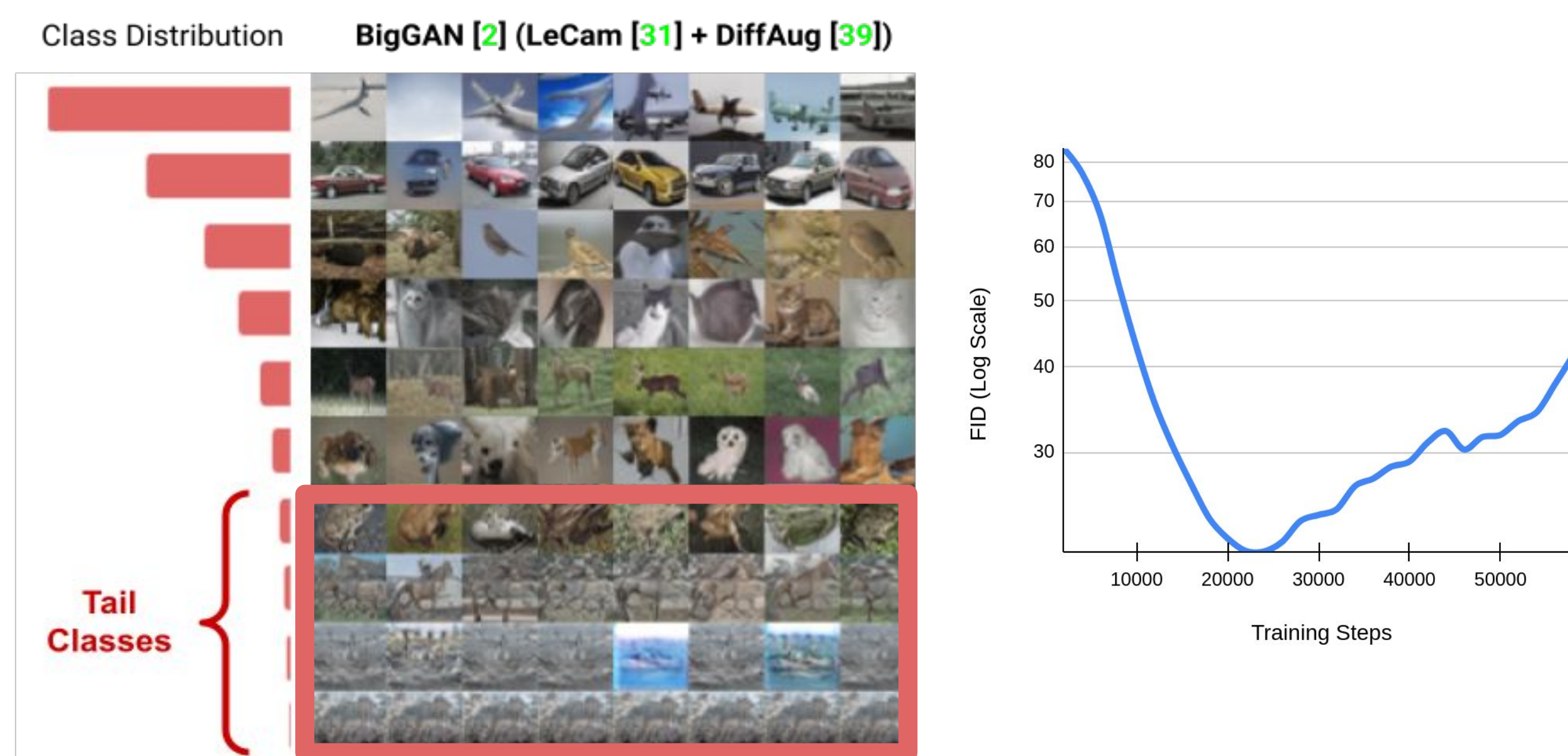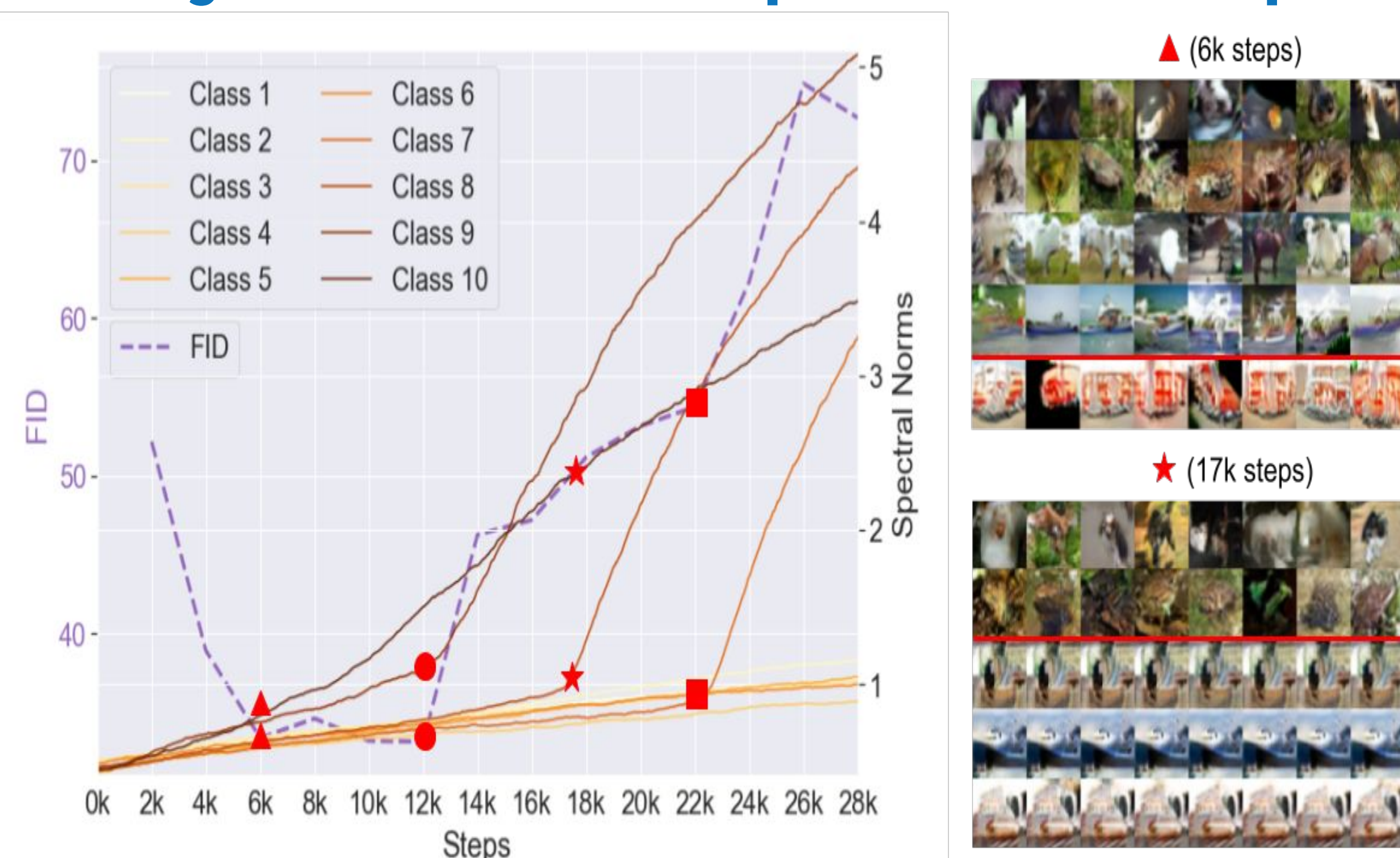
- Long-Tailed Distribution is the natural distribution of categories across species, actions etc.

- In this work we aim to train state-of-the-art conditional GANs on long-tailed datasets.

- We find that the current SotA cGAN training methods suffer from mode-collapse while generating samples from tail classes.

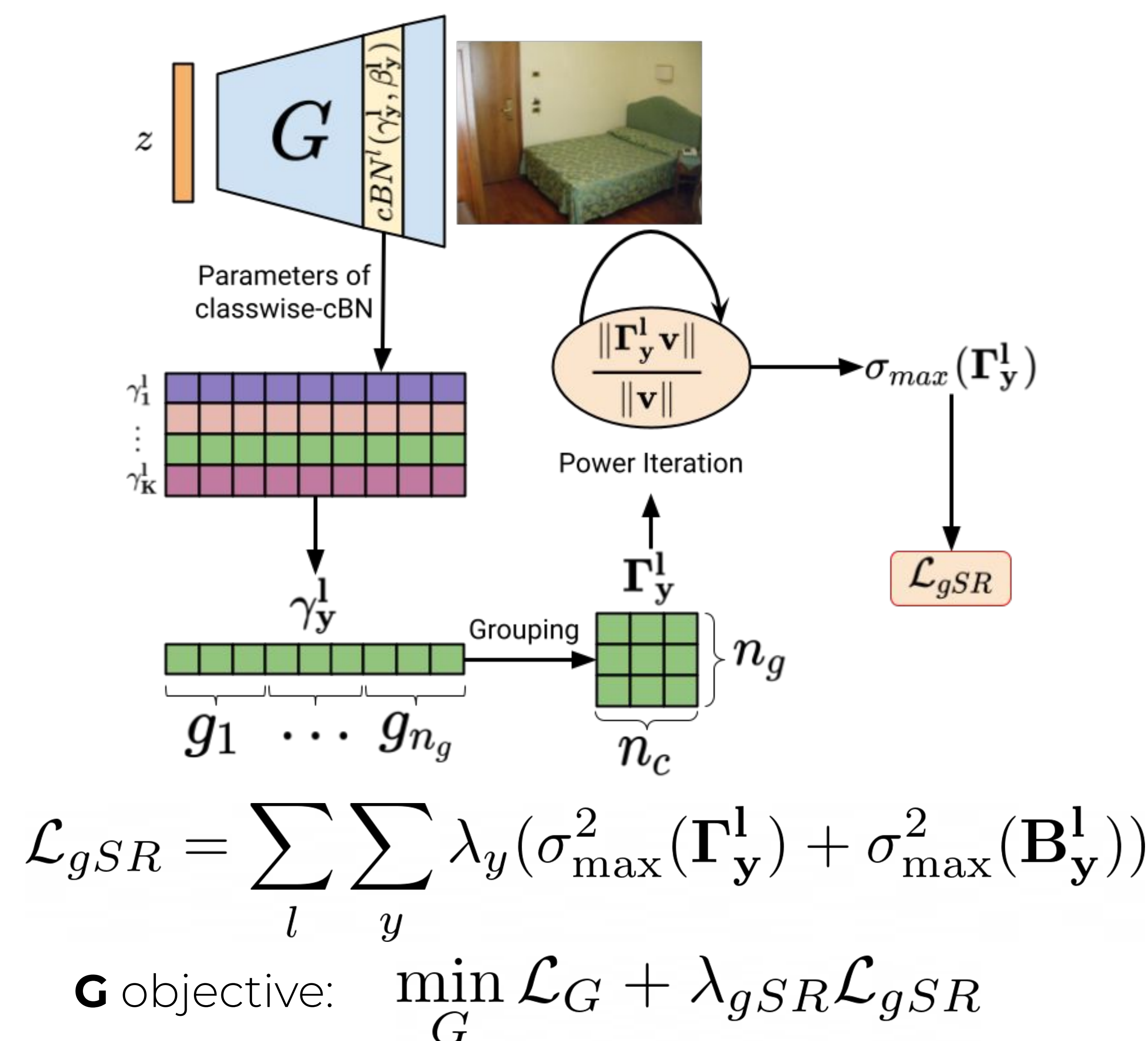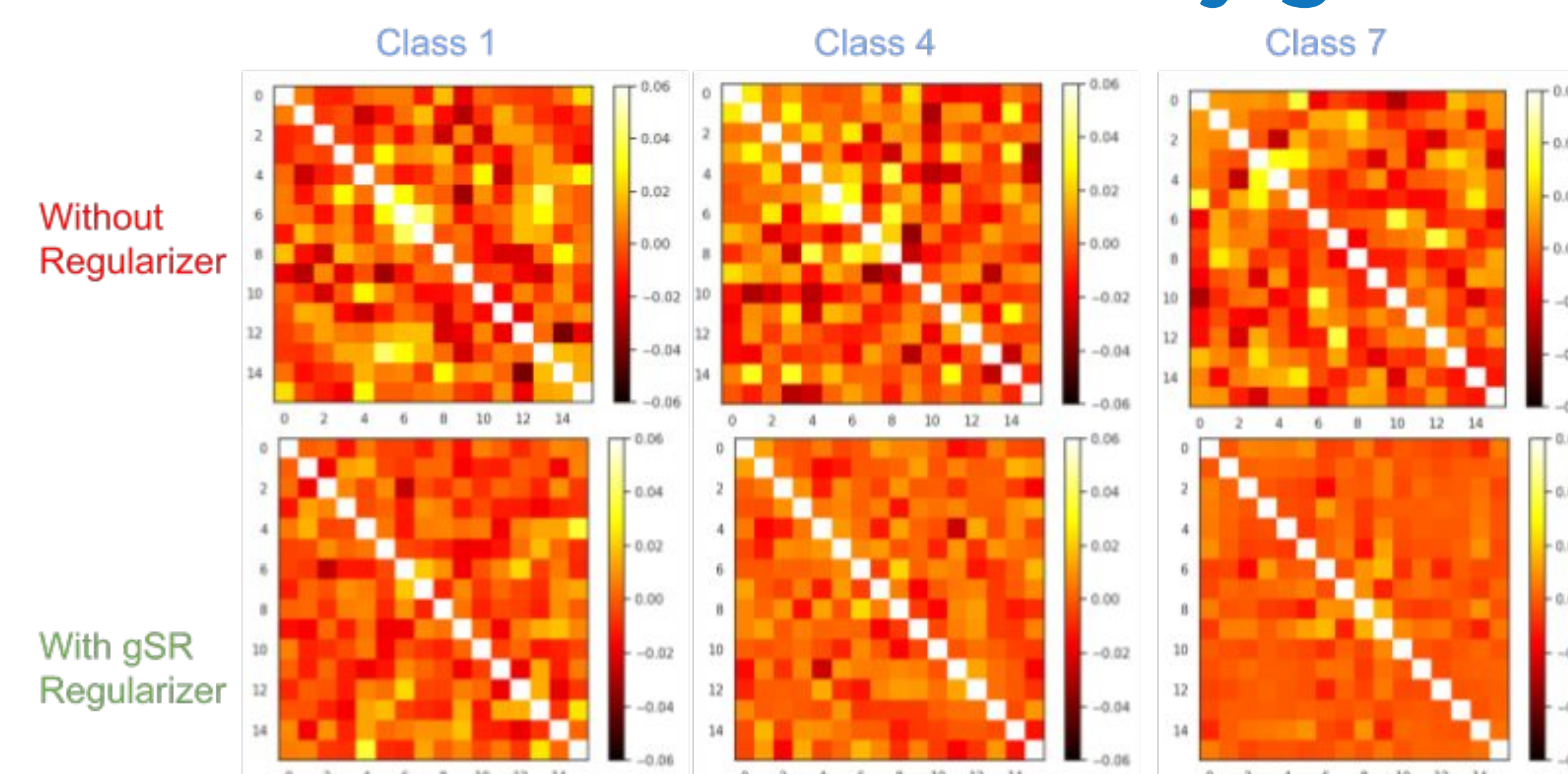## Analysis of Class-Specific Collapse

▲ (6k steps)

★ (17k steps)

We extract the class-specific parameters from generator (G), group them and find spectral norm.

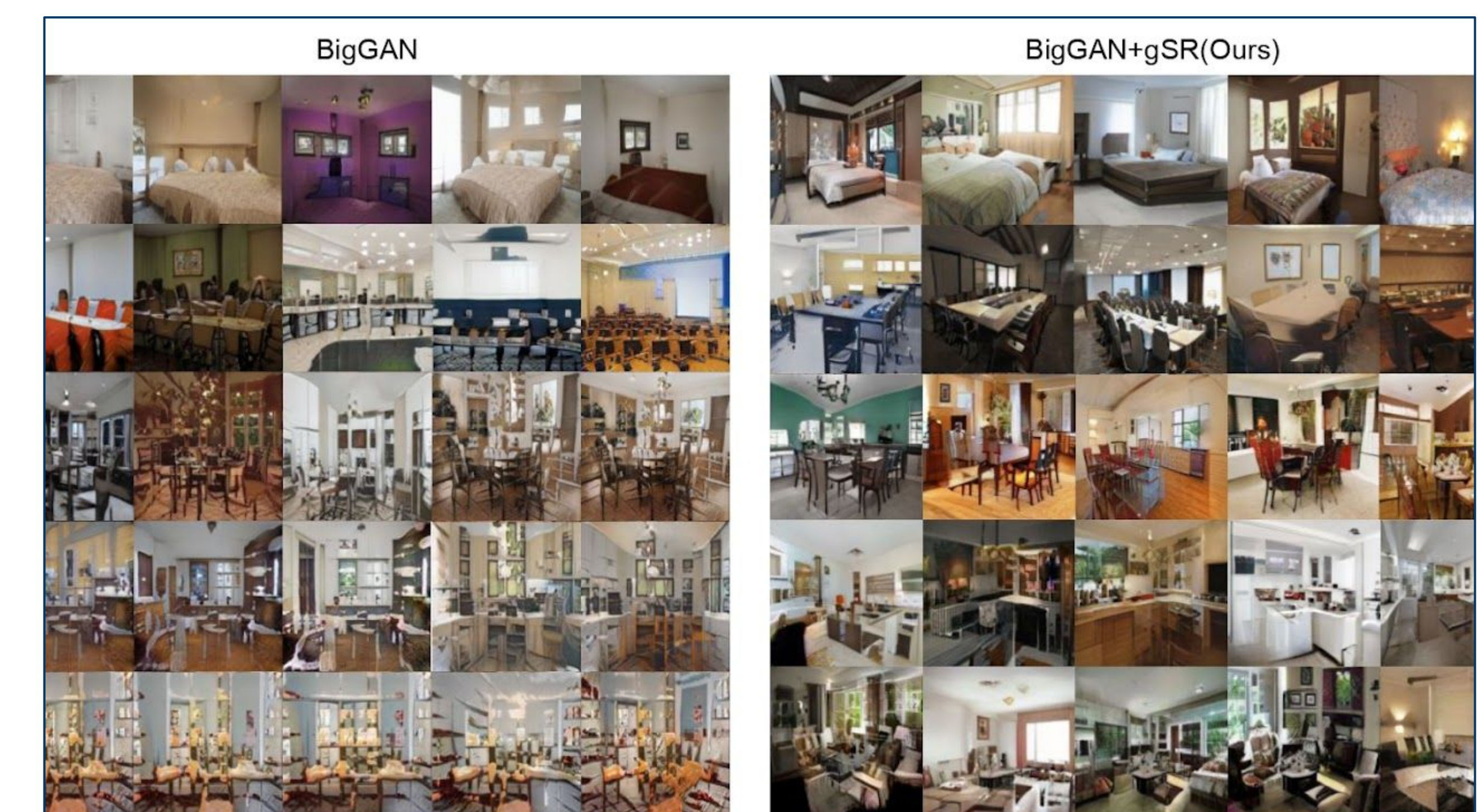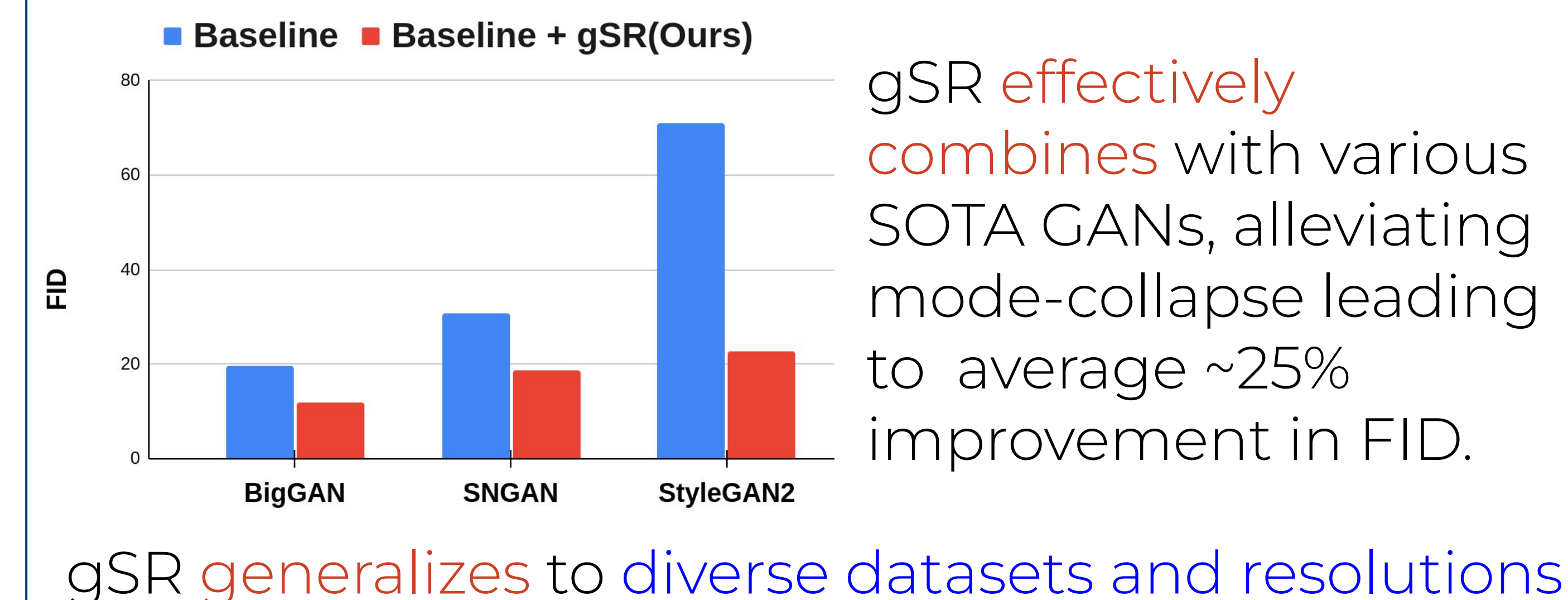**Spectral Collapse** ➡️ **Class Specific Collapse**

group Spectral Regularizer (gSR)

Parameters of classwise-cBN

γ_1^l

γ_k^l

Power Iteration

$\dfrac{\|\mathbf{\Gamma_y^l v}\|}{\|\mathbf{v}\|}$ → $\sigma_{max}(\mathbf{\Gamma_y^l})$

γ_y^l Grouping $\mathbf{\Gamma_y^l}$ } n_g

$\mathcal{L}_{gSR}$

$g_1 \cdots g_{n_g}$ n_c

$$\mathcal{L}_{gSR} = \sum_l \sum_y \lambda_y(\sigma_{\max}^2(\mathbf{\Gamma_y^l}) + \sigma_{\max}^2(\mathbf{B_y^l}))$$

G objective: $\min_G \mathcal{L}_G + \lambda_{gSR}\mathcal{L}_{gSR}$

De-correlation caused by gSR

Class 1   Class 4   Class 7

Without Regularizer

With gSR Regularizer

Why group Spectral Regularization?

- Addition of gSR *consistently* improves performance on imbalanced datasets.

- gSR is inexpensive to compute and compatible with BigGAN, SNGAN, StyleGAN2 architectures.
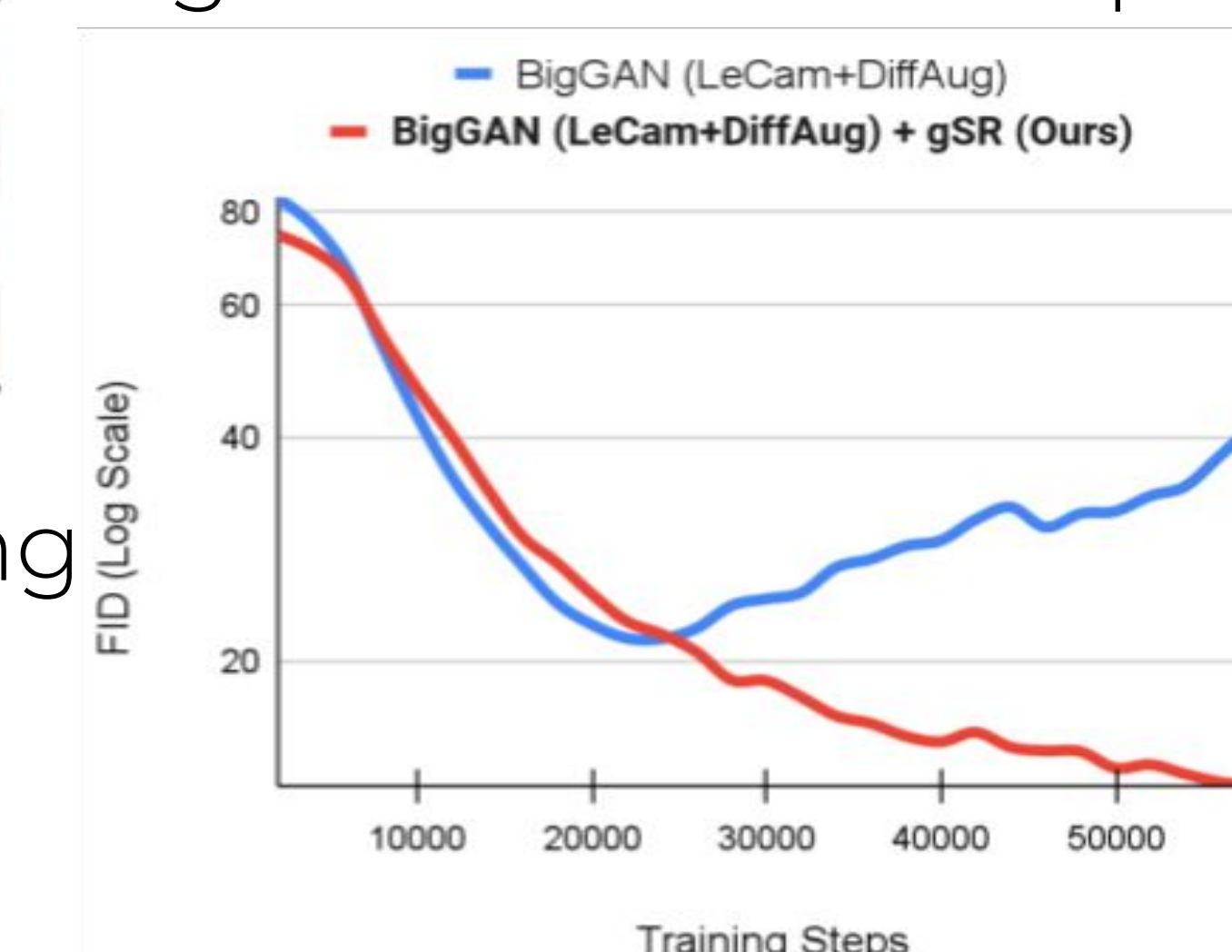
Empirical Results

Baseline   Baseline + gSR(Ours)

gSR effectively combines with various SOTA GANs, alleviating mode-collapse leading to average ~25% improvement in FID.

gSR generalizes to diverse datasets and resolutions

BigGAN   BigGAN+gSR(Ours)

Analysis of gSR (CIFAR-10 LT)

gSR compliments other regularization techniques

LeCam+DiffAug	gSR	FID(↓)	IS(↑)
✗	✗	$31.73_{\pm 0.08}$	$7.18_{\pm 0.02}$
✗	✓	$27.85_{\pm 0.05}$	$7.09_{\pm 0.02}$
✓	✗	$30.62_{\pm 0.07}$	$6.80_{\pm 0.02}$
✓	✓	$\mathbf{18.58_{\pm 0.10}}$	$\mathbf{7.80_{\pm 0.09}}$

BigGAN (LeCam+DiffAug)
BigGAN (LeCam+DiffAug) + gSR (Ours)

gSR stablizes GAN training on imbalanced data, leading to improved FID.

Acknowledgement

Project: https://sites.google.com/view/gsr-eccv22