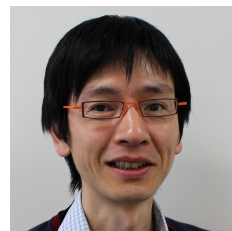# Noise Robust Generative Adversarial Networks

Takuhiro Kaneko[1]
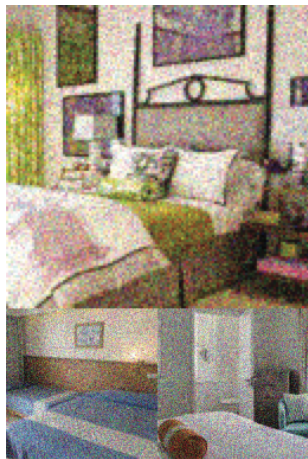
Tatsuya Harada[1,2]

Background: Limitations of standard GANs

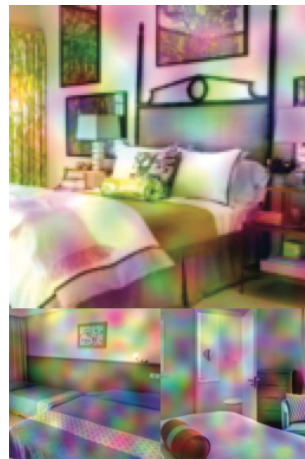- In spite of *noise*, standard **GANs** mimic training images.

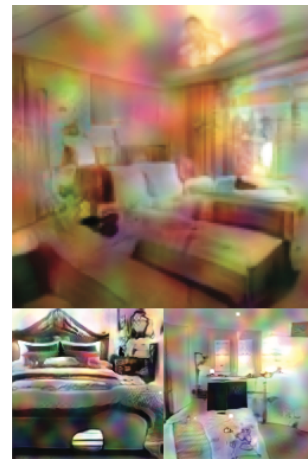**Training images** **Generated images** **Training images** **Generated images**

GAN →

Noisy *Noisy* *Noisy* *Noisy*

GAN: Goodfellow et al., NIPS 2014.

Proposal: Noise robust GANs (NR-GANs)

- We propose **NR-GANs**, which can learn a *clean image generator*, even when only *noisy images* are available for training.
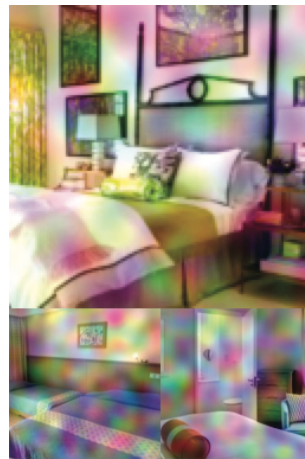
Training images   **Generated images**   **Training images**   **Generated images**

Noisy   NR-GAN   *Clean*   *Noisy*   NR-GAN   *Clean*
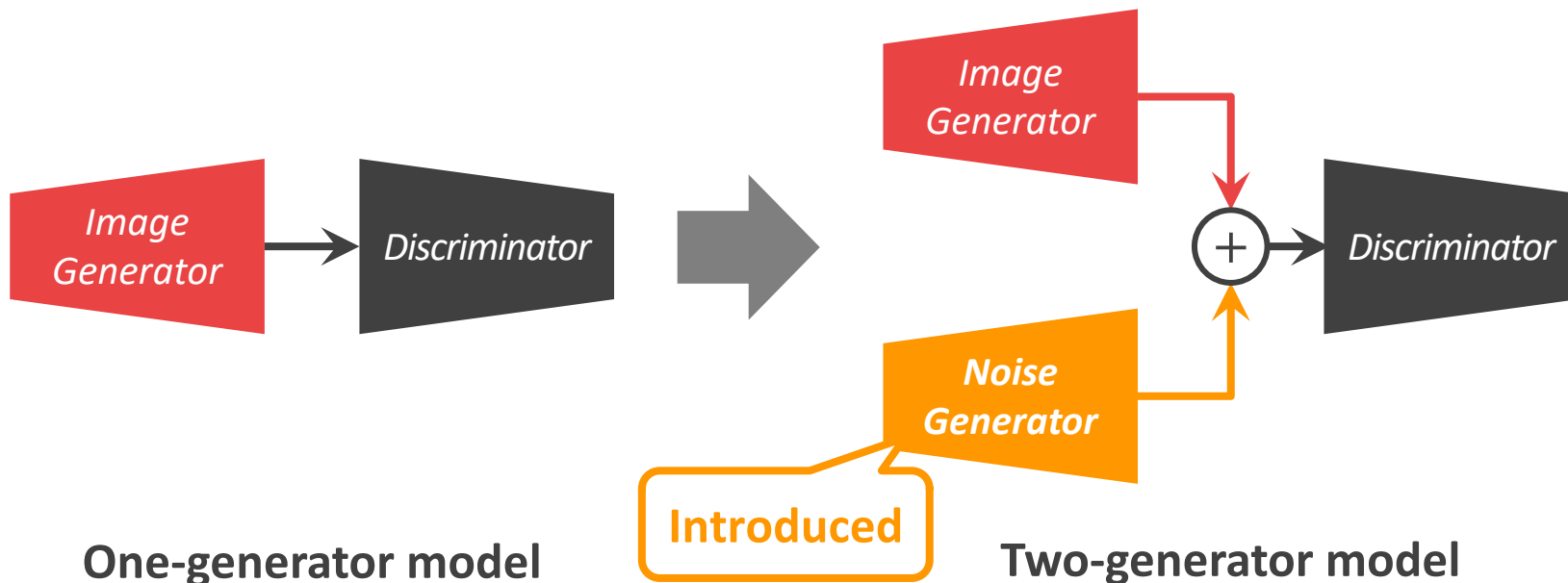
Key idea I: Two-generator model

- Introduce a **two-generator model** consisting of **image** and **noise** generators

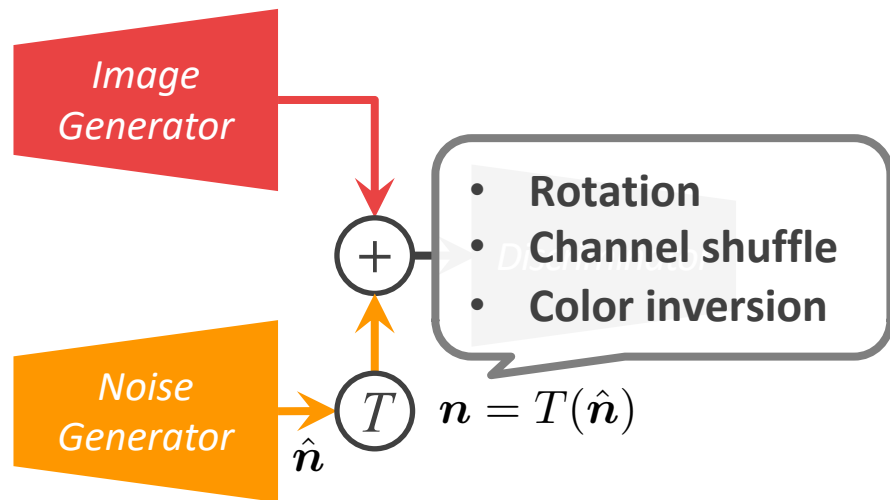**One-generator model**   **Two-generator model**

Question: *How to generate an image and noise separately?*

Key idea II: Distribution or transformation constraint

- Impose a **distribution/transformation constraint** on the **noise** generator
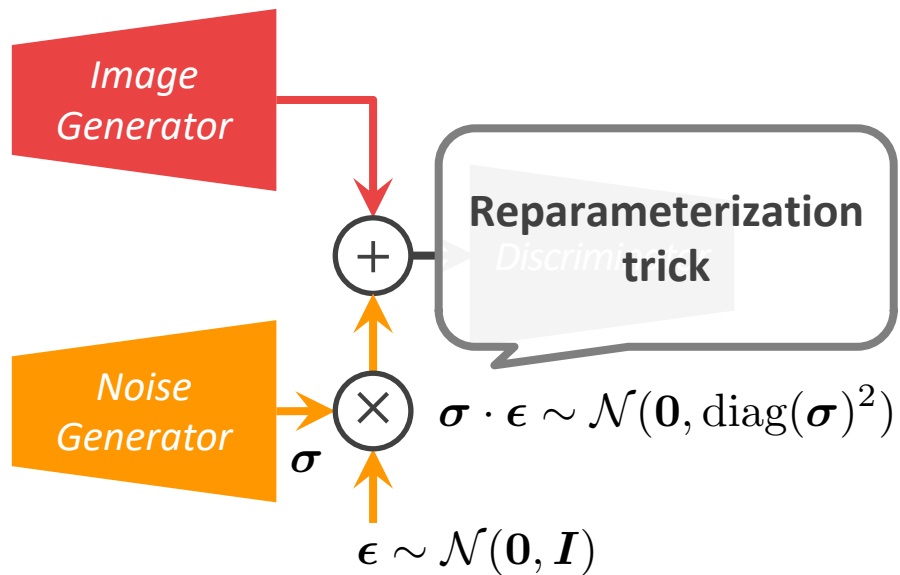
Distribution constraint

$$\boldsymbol{\sigma} \cdot \boldsymbol{\epsilon} \sim \mathcal{N}(\mathbf{0}, \operatorname{diag}(\boldsymbol{\sigma})^2)$$

$$\boldsymbol{\epsilon} \sim \mathcal{N}(\mathbf{0}, \boldsymbol{I})$$

Reparameterization trick

Transformation constraint

$$\boldsymbol{n} = T(\hat{\boldsymbol{n}})$$

- **Rotation**
- **Channel shuffle**
- **Color inversion**

Reparameterization trick: Kingma & Welling, ICLR 2014.
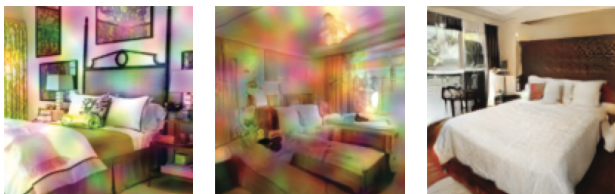
Experiments

- ## Noise robust image generation

Signal-independent noise

Additive Gaussian noise

Brown Gaussian noise

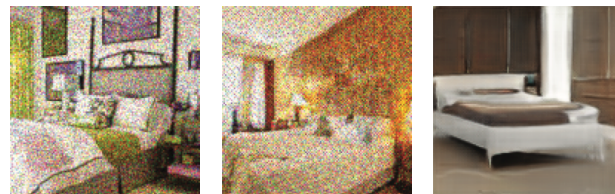Training images   GAN   NR-GAN

Signal-dependent noise

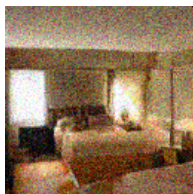**Multiplicative Gaussian noise**
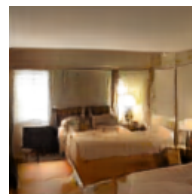
Poisson noise

Training images   GAN   NR-GAN

- ## Application: Image denoising

Generated noisy image
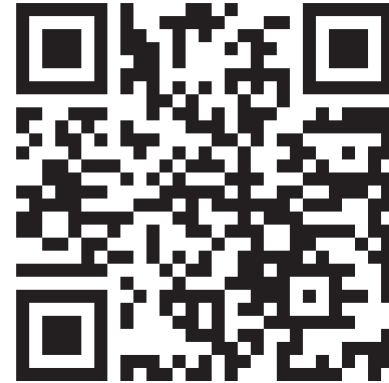
GN2GC

Generated clean image

LSUN dataset: Yu et al., 2015.   6

Thank you!

Our code and project page are available online.

Code

https://github.com/takuhirok/NR-GAN/

Project page

https://takuhirok.github.io/NR-GAN/