

Generative Adversarial Networks

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Plan:

1. DCGAN
2. WGAN
 - «Vanilla» WGAN
 - WGAN-GP
3. Progressive growing of GANs
4. Are GANs good latent models?
5. Some examples of GANs-based results
6. Conclusion

DCGAN [Radford et al., 2015]

100 years ago: «The most important art is cinema»

Now: «The most important art is tuning GANs»

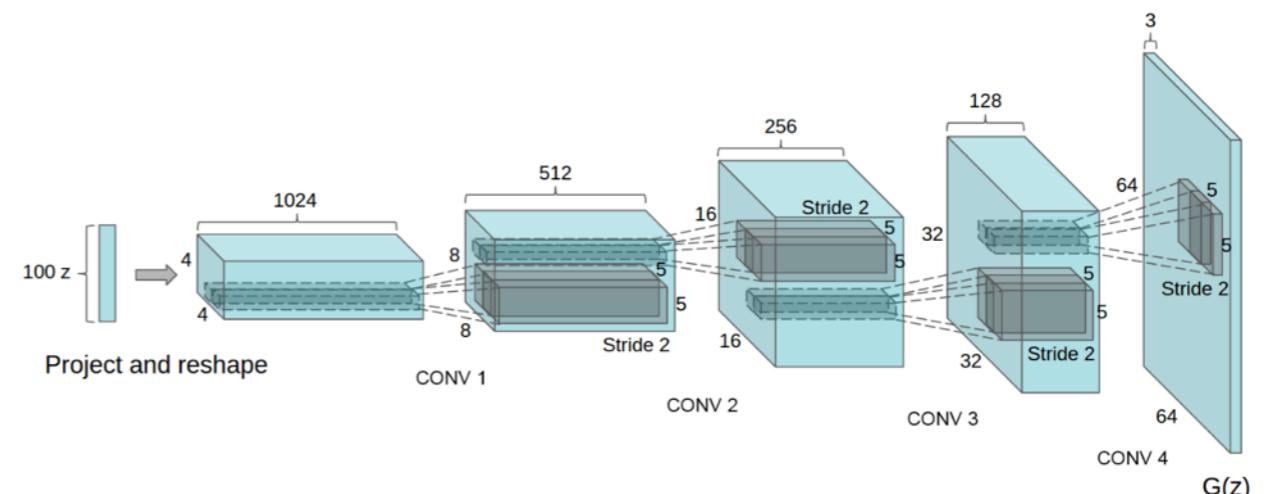
- No Max-pooling, use strides instead!

- Use batch-norms in D and G

- Use ADAM

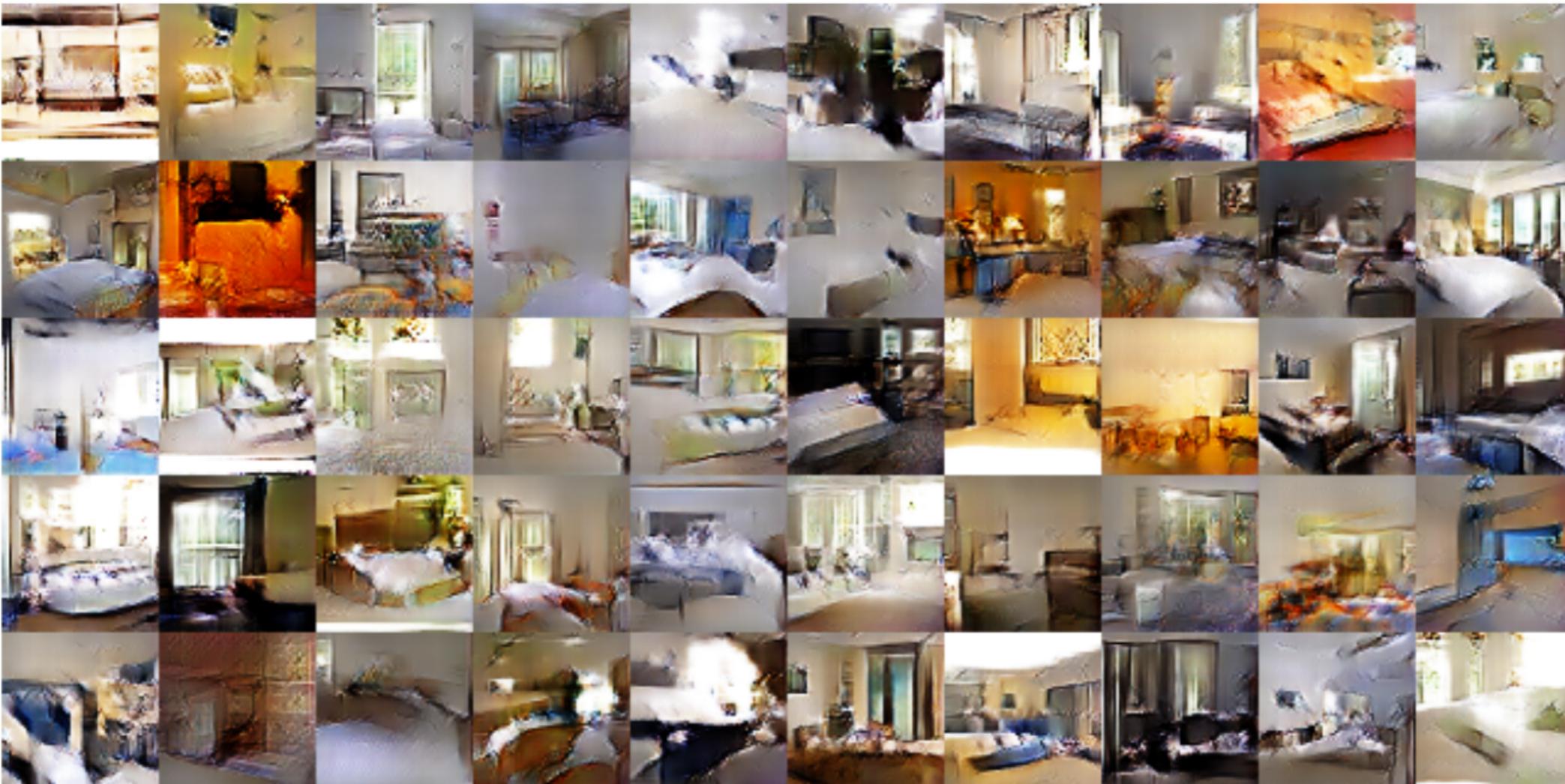
- For Generator use: ReLU + tanh

- For Discriminator use: Leaky ReLU



[Radford et al., 2015]

DCGAN Results



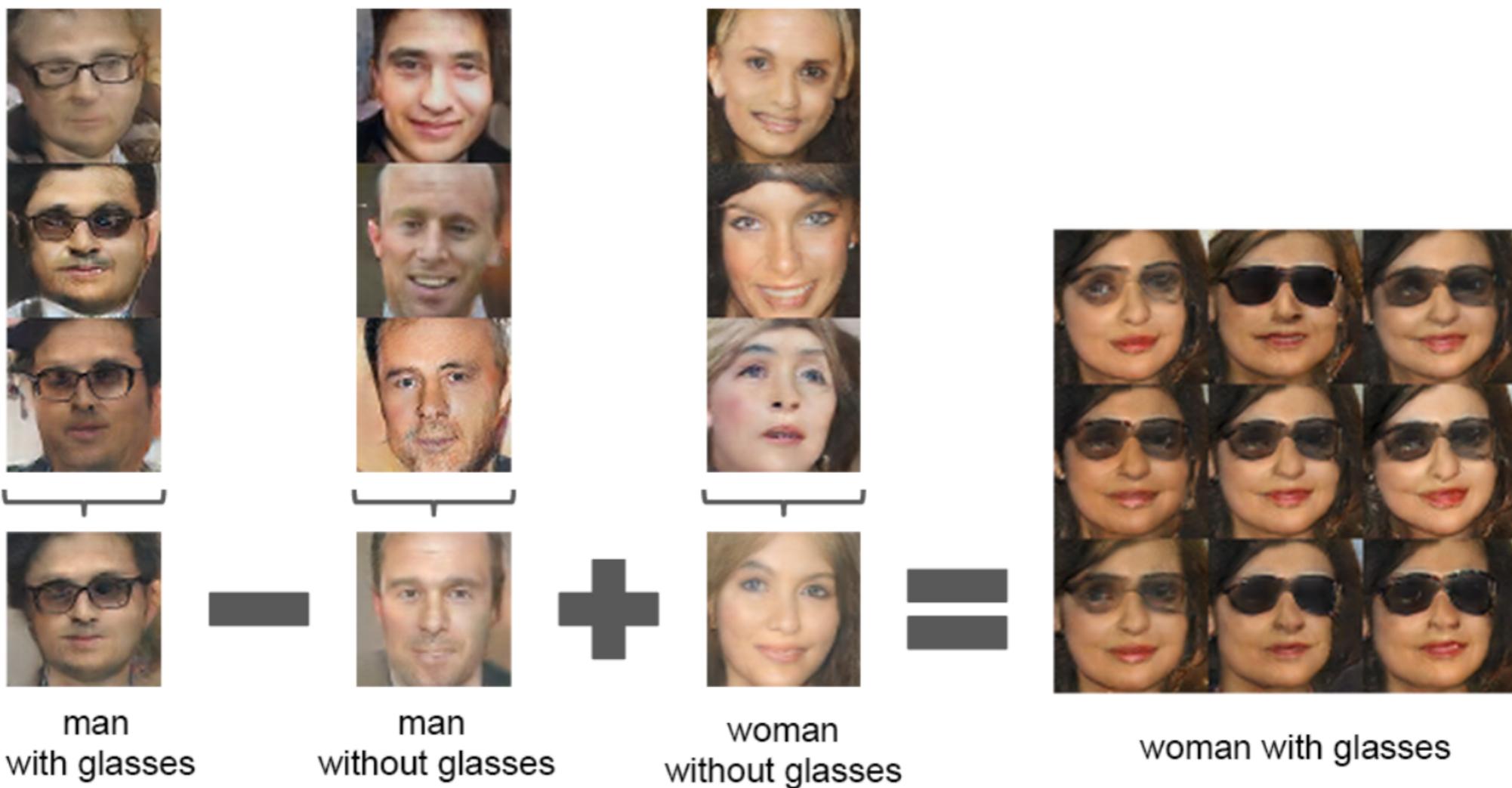
[Radford et al., 2015]

DCGAN Results



[Radford et al., 2015]

DCGAN



[Radford et al., 2015]

Mode Collapse



[Radford et al., 2015]

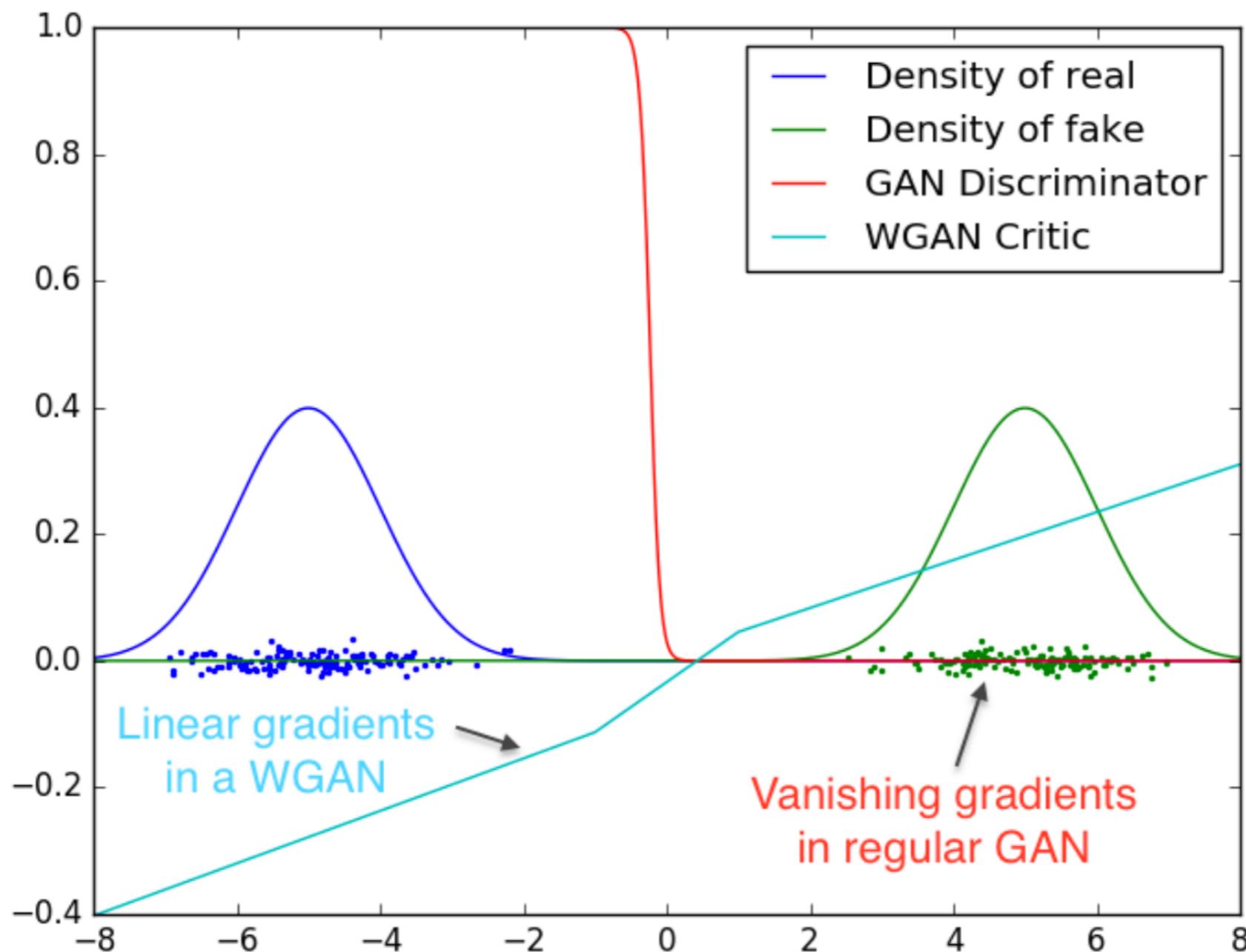
WGAN [Arjovsky et al., 2017]

Earth-Mover distance: $W(\mathbb{P}_r, \mathbb{P}_g) = \inf_{\gamma \in \Pi(\mathbb{P}_r, \mathbb{P}_g)} \mathbb{E}_{(x,y) \sim \gamma} [\|x - y\|]$

New Generator's task: $\min_g W(X || g(Z))$

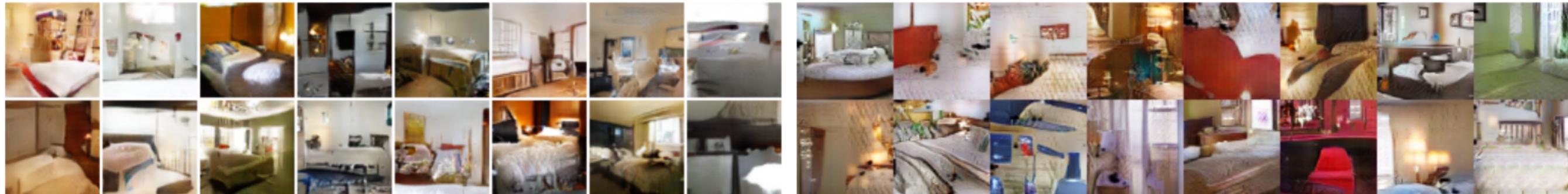
Kantorovich-Rubinstein duality $W(\mathbb{P}_r, \mathbb{P}_\theta) = \sup_{\|f\|_L \leq 1} \mathbb{E}_{x \sim \mathbb{P}_r} [f(x)] - \mathbb{E}_{x \sim \mathbb{P}_\theta} [f(x)]$

WGAN vs GAN



[Arjovsky et al., 2017]

WGAN vs DCGAN

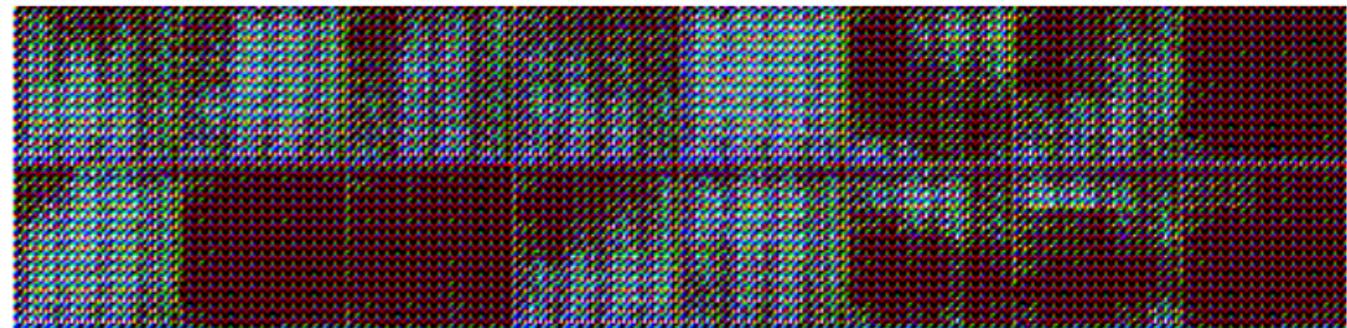


WGAN with good parameters

DCGAN with good parameters



WGAN with poor parameters



DCGAN with poor parameters

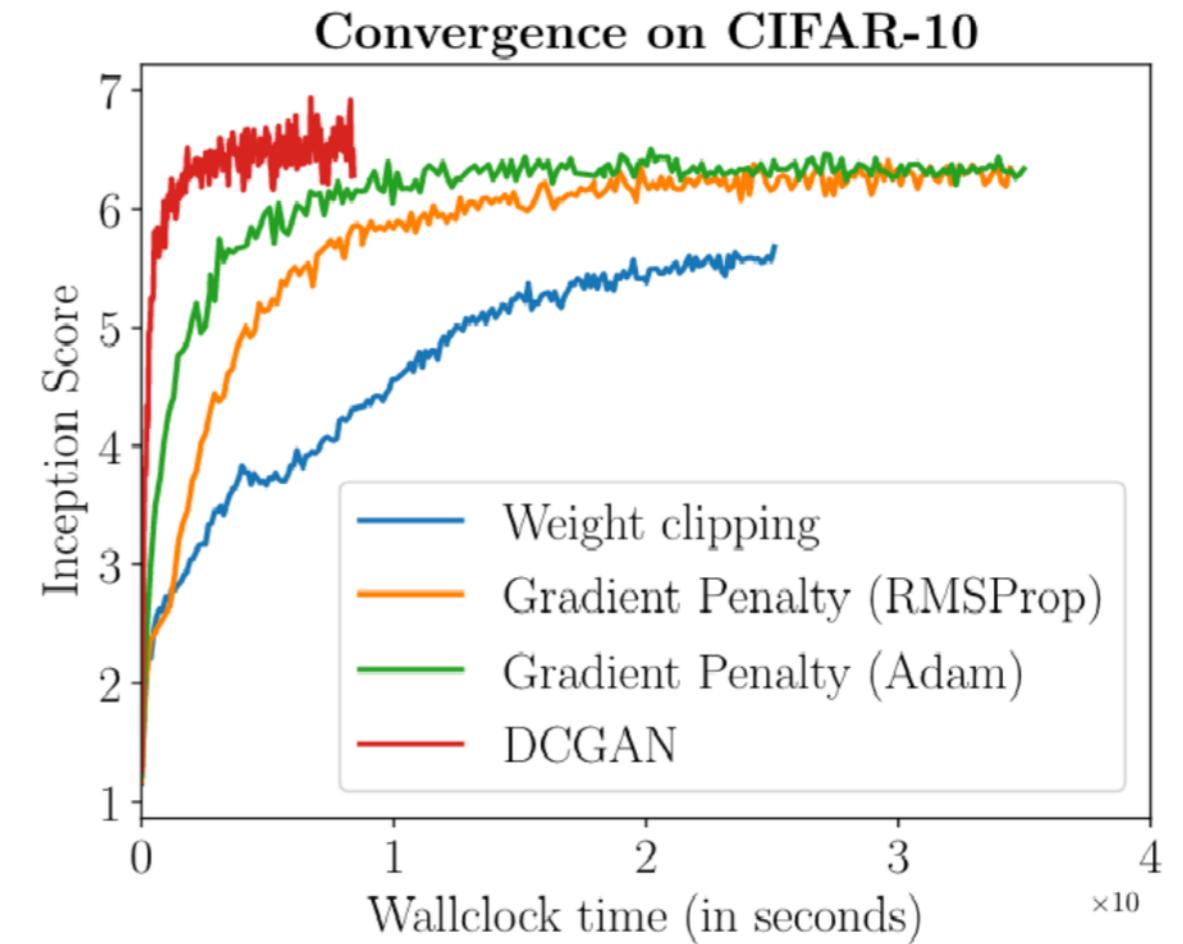
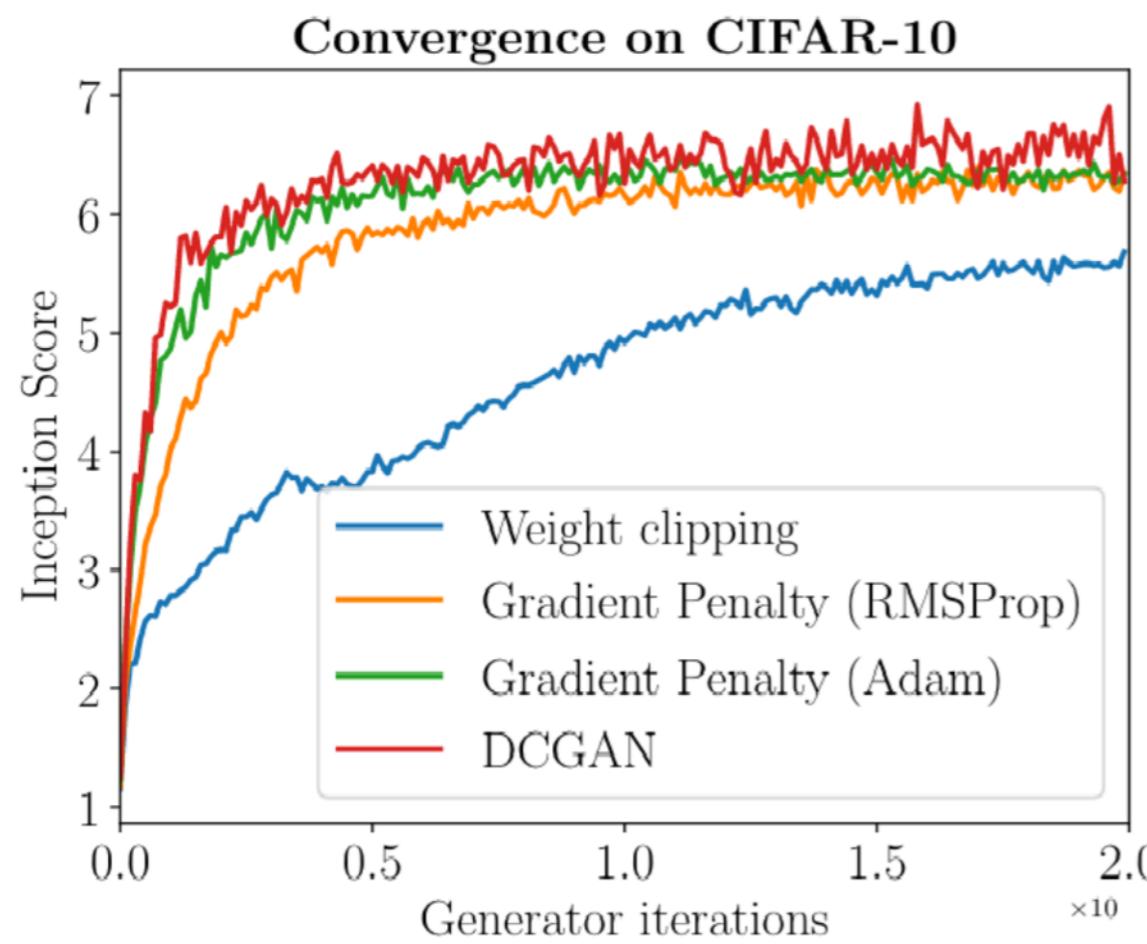
[Arjovsky et al., 2017]

WGAN-GP

It is better not to clip the weights, but to update critic's loss function!

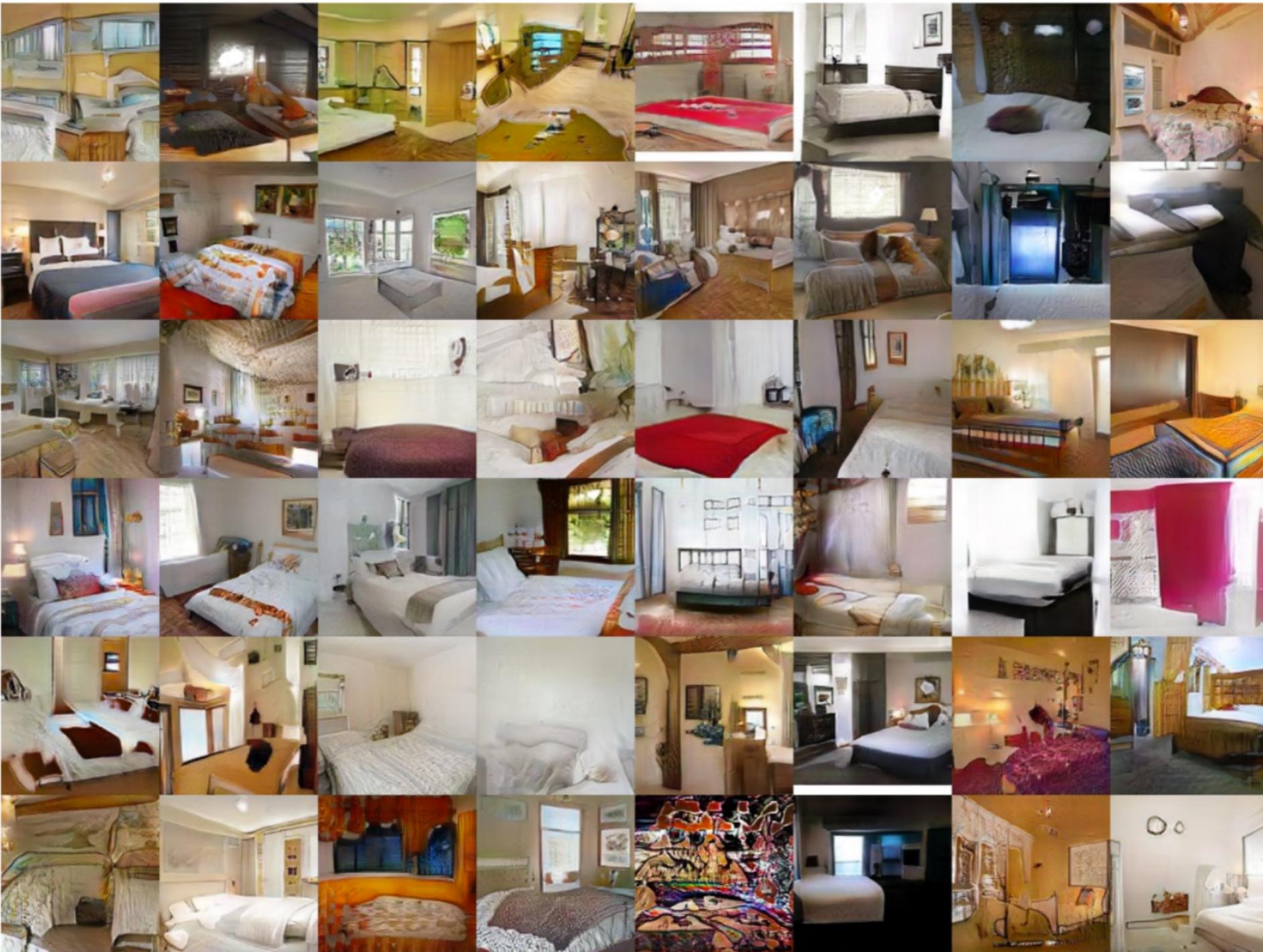
$$L = \underbrace{\mathbb{E}_{\tilde{\mathbf{x}} \sim \mathbb{P}_g} [D(\tilde{\mathbf{x}})] - \mathbb{E}_{\mathbf{x} \sim \mathbb{P}_r} [D(\mathbf{x})]}_{\text{Original critic loss}} + \lambda \underbrace{\mathbb{E}_{\hat{\mathbf{x}} \sim \mathbb{P}_{\hat{\mathbf{x}}}} [(\|\nabla_{\hat{\mathbf{x}}} D(\hat{\mathbf{x}})\|_2 - 1)^2]}_{\text{Our gradient penalty}}.$$

WGAN-GP



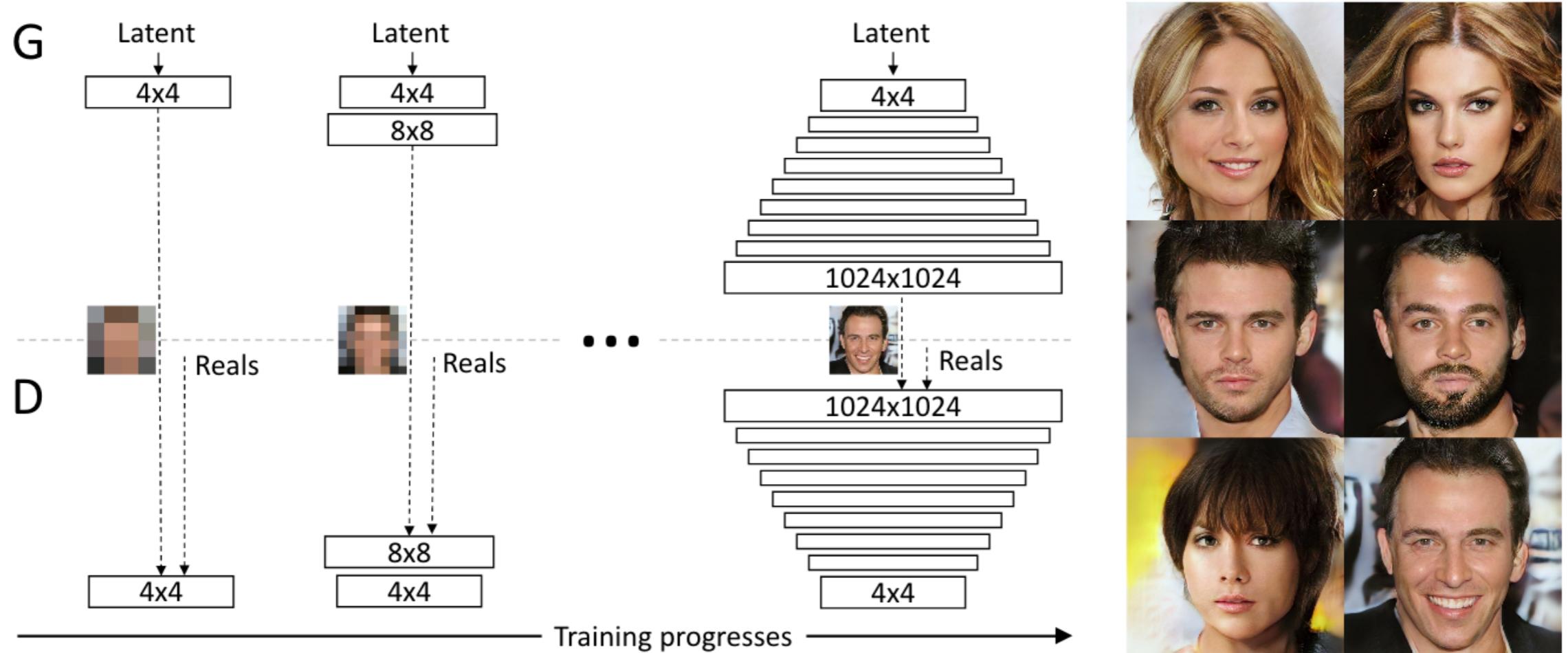
[Arjovsky et al., 2017]

WGAN-GP



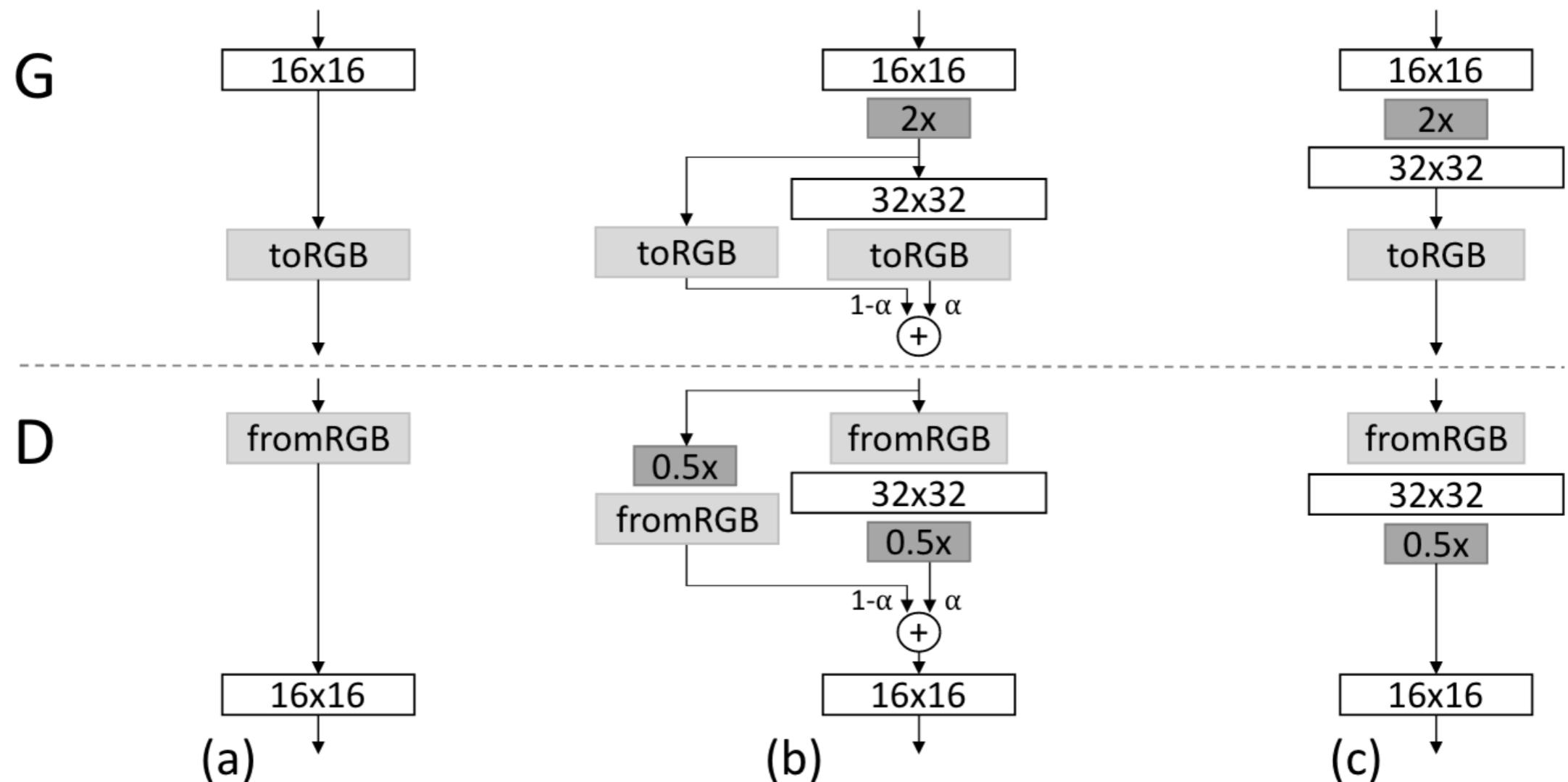
[Arjovsky et al., 2017]

Progressive Growing of GANs [Karras et al., 2018]



[Karras et al., 2018]

Progressive Growing of GANs



[Karras et al., 2018]

Progressive Growing of GANs



[Karras et al., 2018]

Progressive Growing of GANs



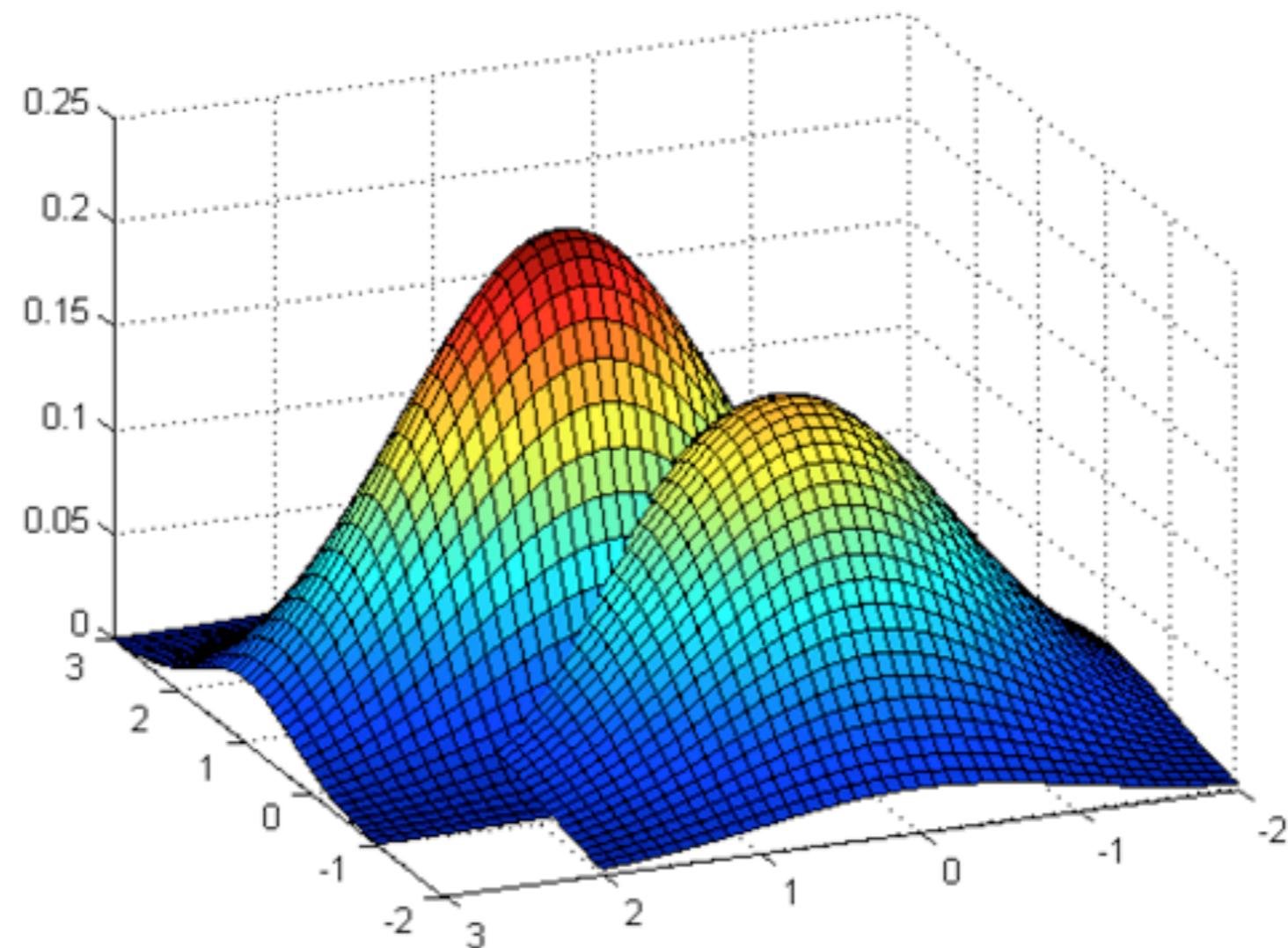
Mao et al., 2016

Gulrajani et al., 2017

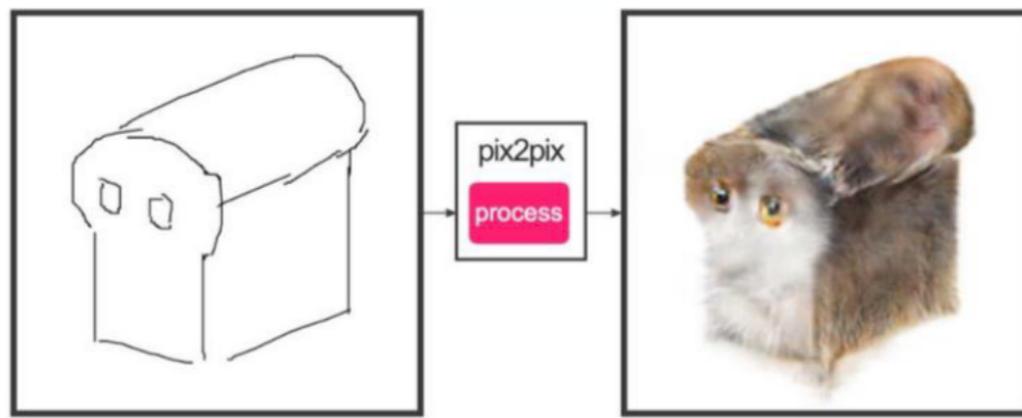
Progressive Growing
of GANs, 2018

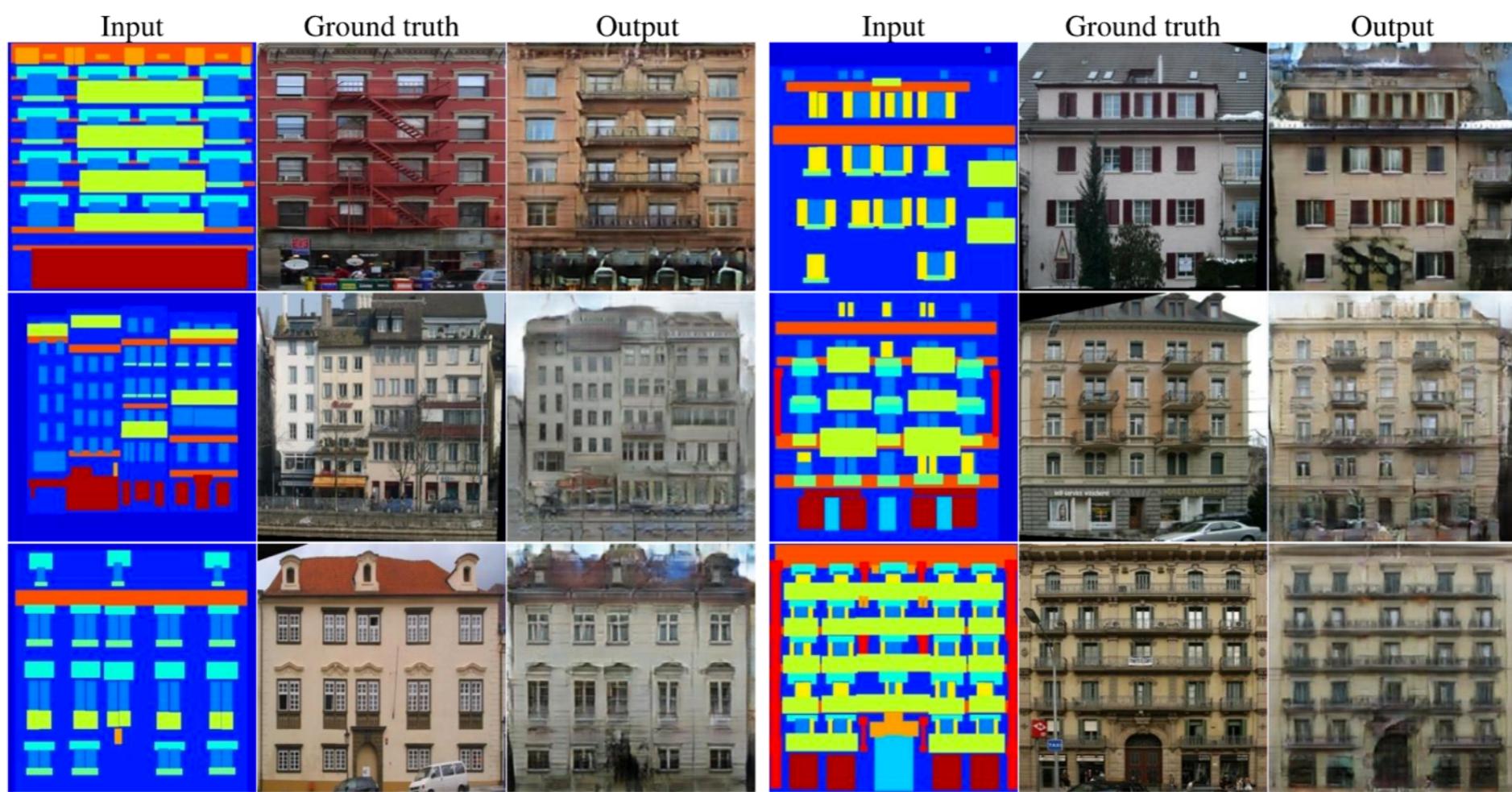
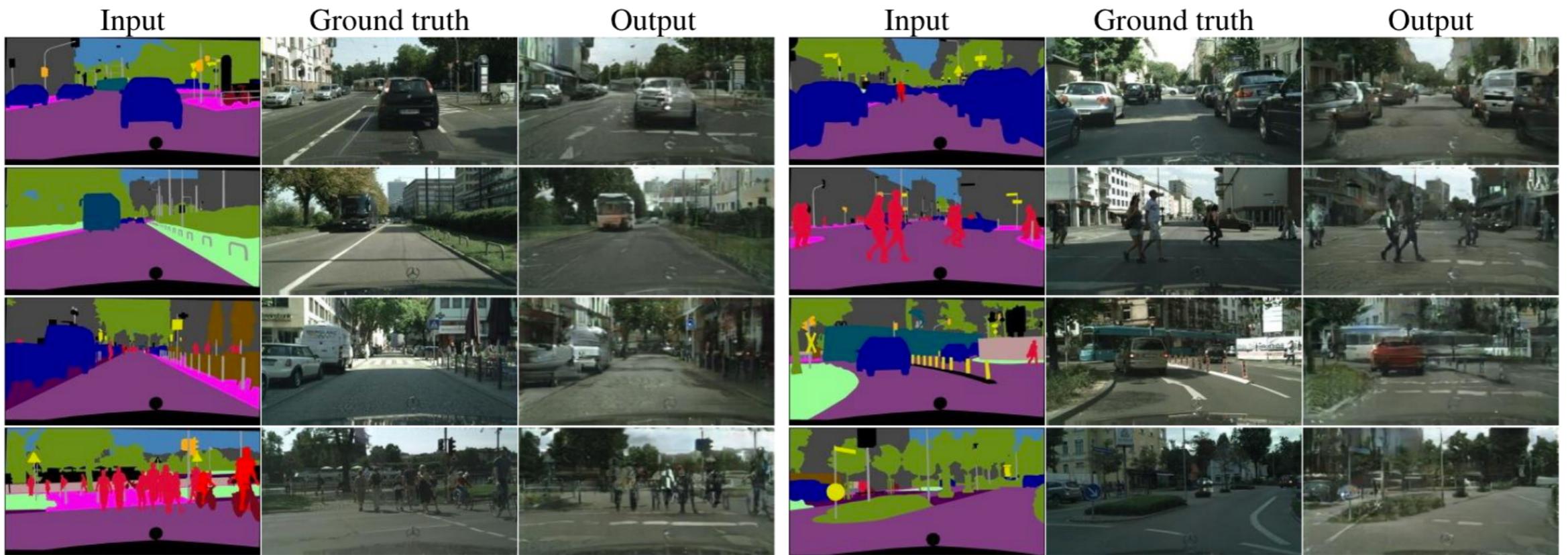
[Karras et al., 2018]

Are GANs good latent models?



Some Results





Monet **Photos**



Monet → photo



photo → Monet

Zebras **Horses**



zebra → horse



horse → zebra

Summer **Winter**



summer → winter



winter → summer



Photograph



Monet



Van Gogh



Cezanne



Ukiyo-e

bicubic
(21.59dB/0.6423)



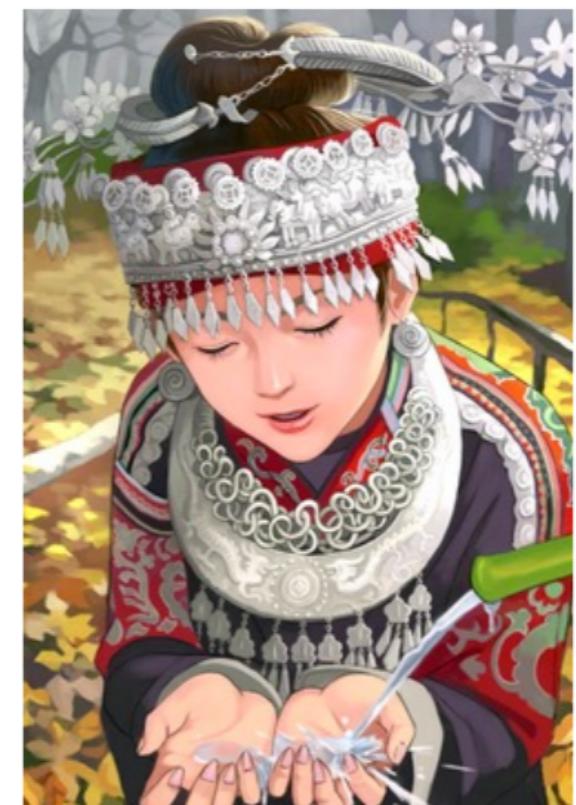
SRResNet
(23.53dB/0.7832)



SRGAN
(21.15dB/0.6868)



original



Conclusion

- GANs are quite powerful generative models, but still there are some problems
- GANs are unstable
- DCGAN >> «Vanilla» GAN
- WGAN > DCGAN
- WGAN-GP > WGAN (as far as WGAN use some «magic» constants)
- GANs = Hype

Papers:

- Wasserstein GAN [arXiv:1701.07875]
- Improved Training of Wasserstein GANs [arXiv: 1704.00028]
- Progressive Growing of GANs [arXiv:1710.10196]
- Generative Adversarial Networks [arXiv:1406.2661]