By Bruce Lee

StarGAN v2:
Diverse Image Synthesis for Multiple Domains

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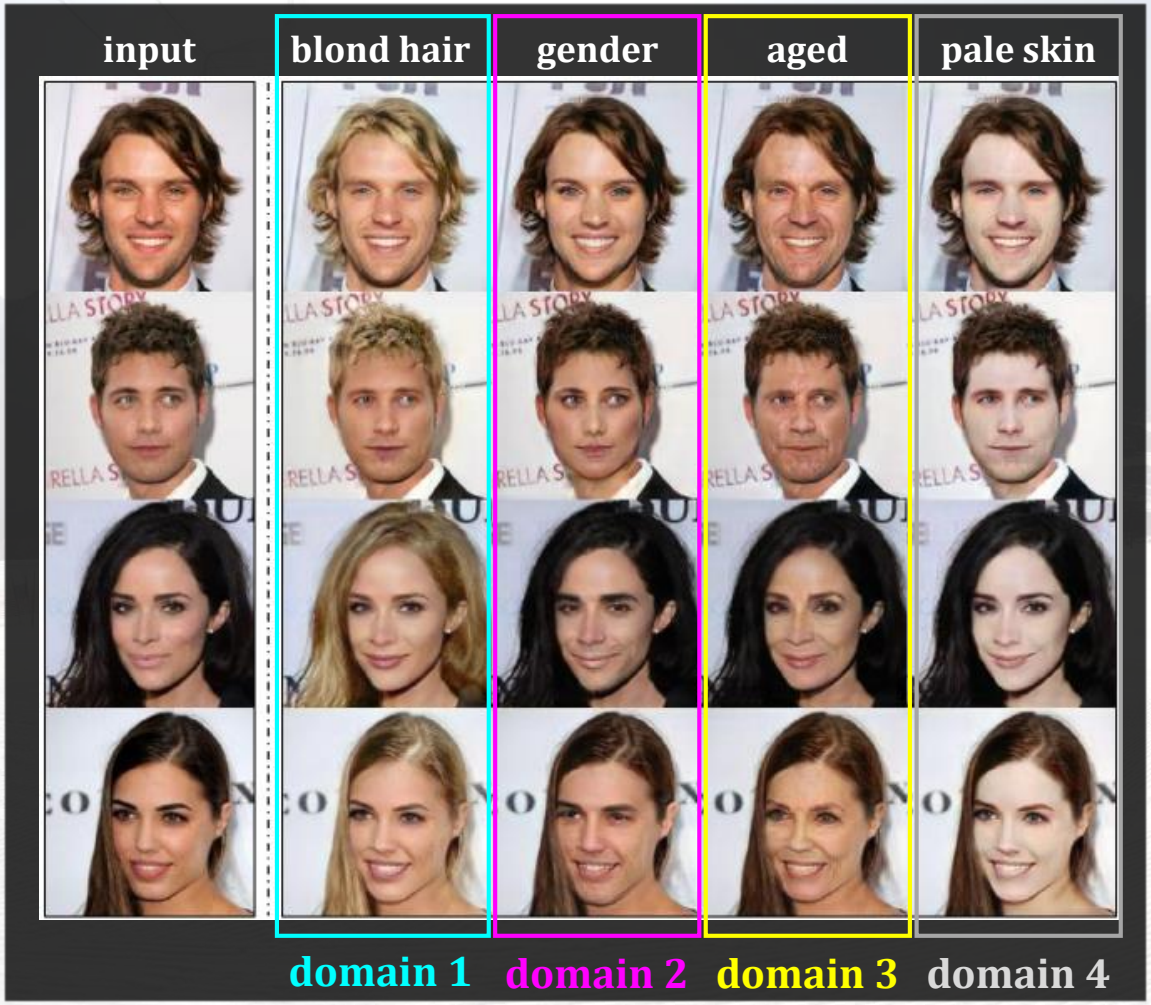
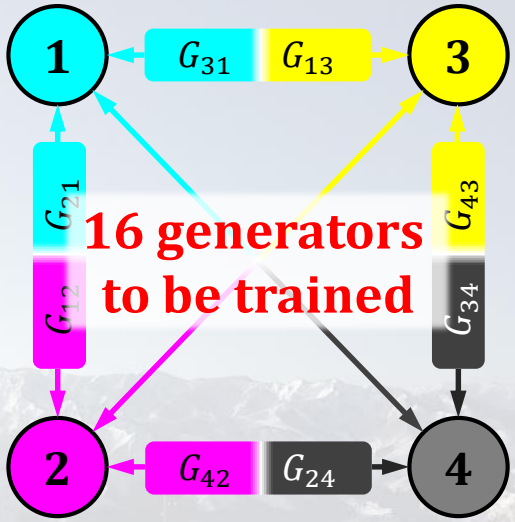
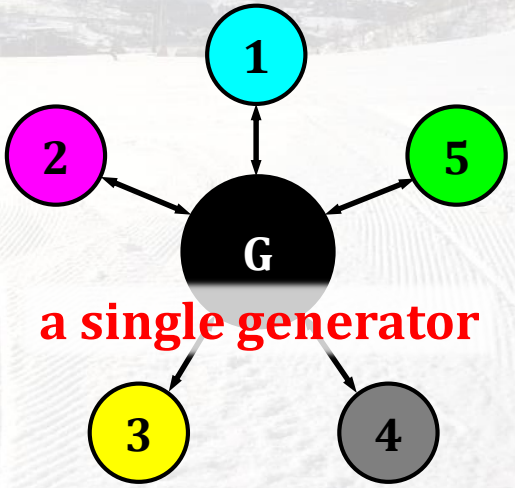
Once upon a time…

- StarGAN v1 in 2018 IEEE/CVF CVPR

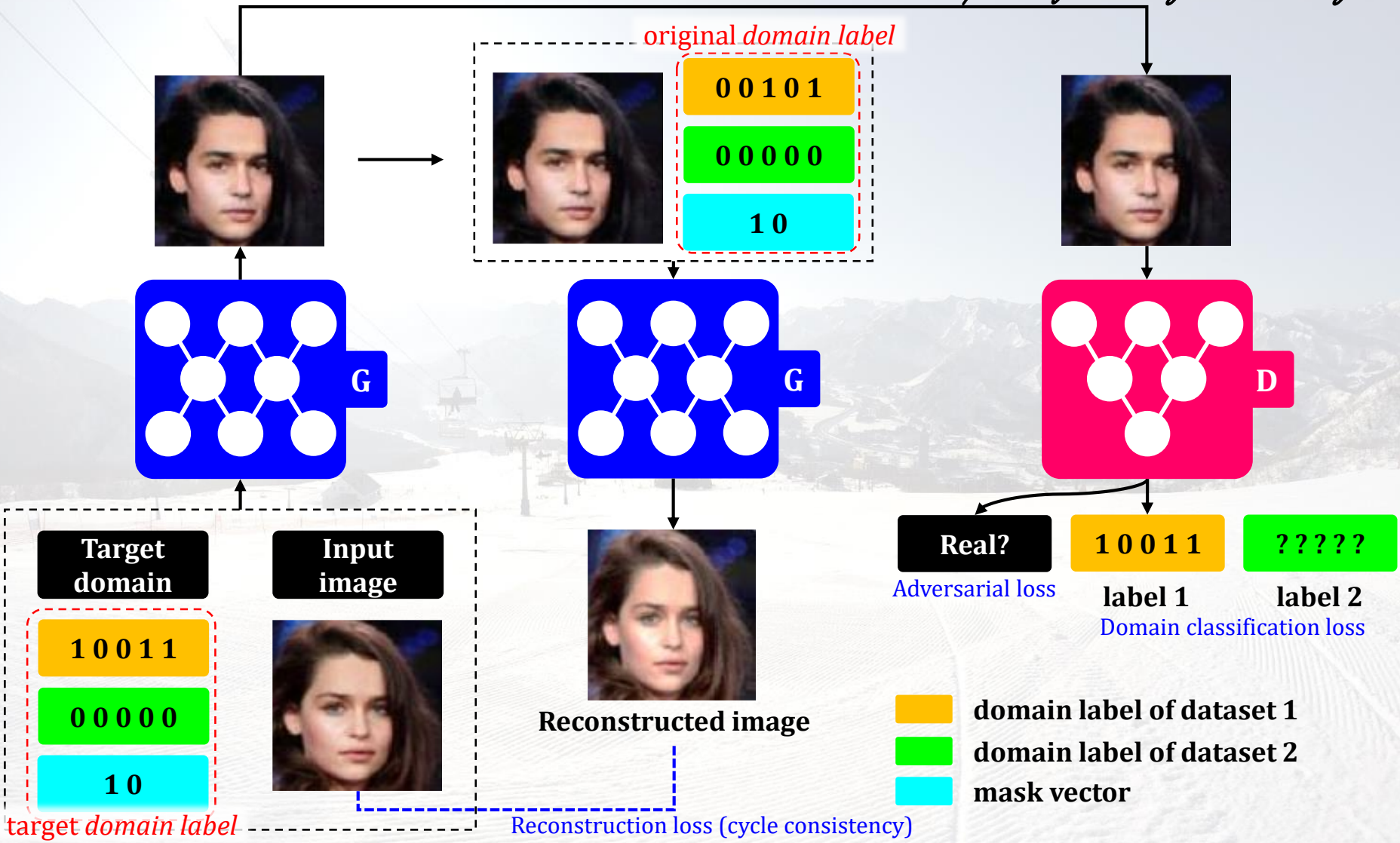






Ref: Y. Choi, *et al.*, Stargan: Unified generative adversarial networks for multi-domain image-to-image translation. In *CVPR*, 2018.

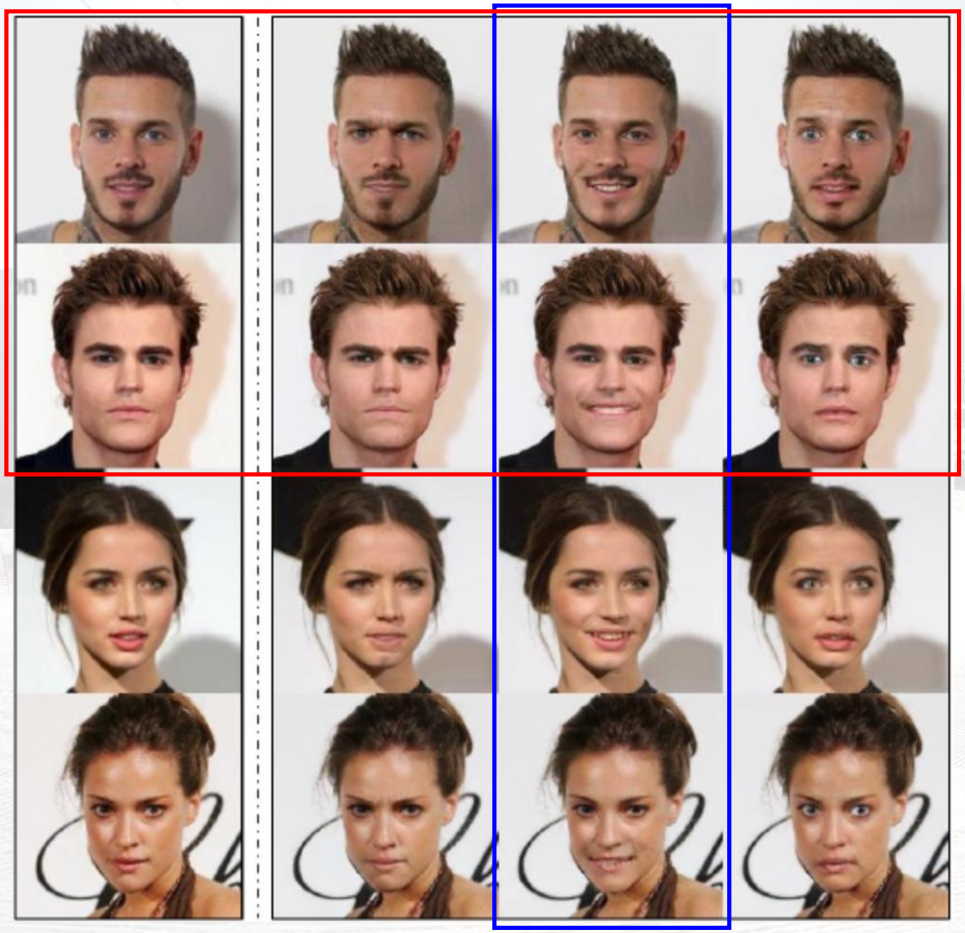
StarGAN v1: Target *domain label* and *mask vector*



Ref: Y. Choi, *et al.*, Stargan: Unified generative adversarial networks for multi-domain image-to-image translation. In *CVPR*, 2018.

Here comes the problem

- Domain implies a set of images that can be grouped as visually distinctive category with *different styles*.



In StarGAN v1, this is a single domain *i*

In StarGAN v2, they should all be grouped as a single domain *i* (e.g., based on gender). Each image has a unique appearance called *style*. In this case, the *domain* is *Male*, and there are different styles *Angry*/*Happy*/*Fearful*.

StarGAN v1: **domain label**

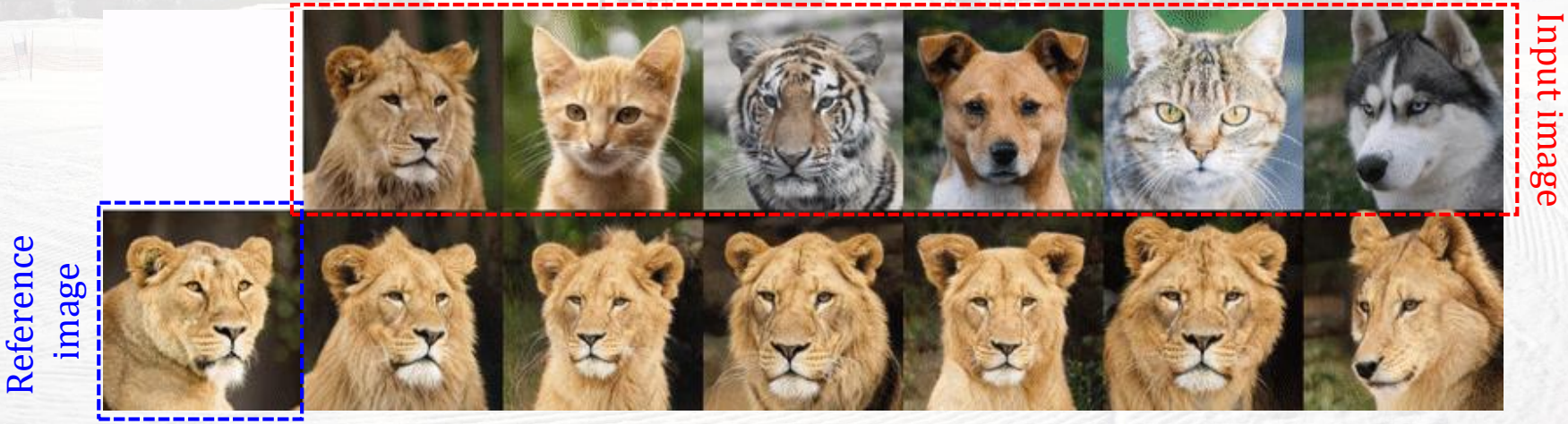
StarGAN v2: **style code**

Ref: Y. Choi, *et al.*, Stargan: Unified generative adversarial networks for multi-domain image-to-image translation. In *CVPR*, 2018.

Before we start, there is one thing you SHOULD know

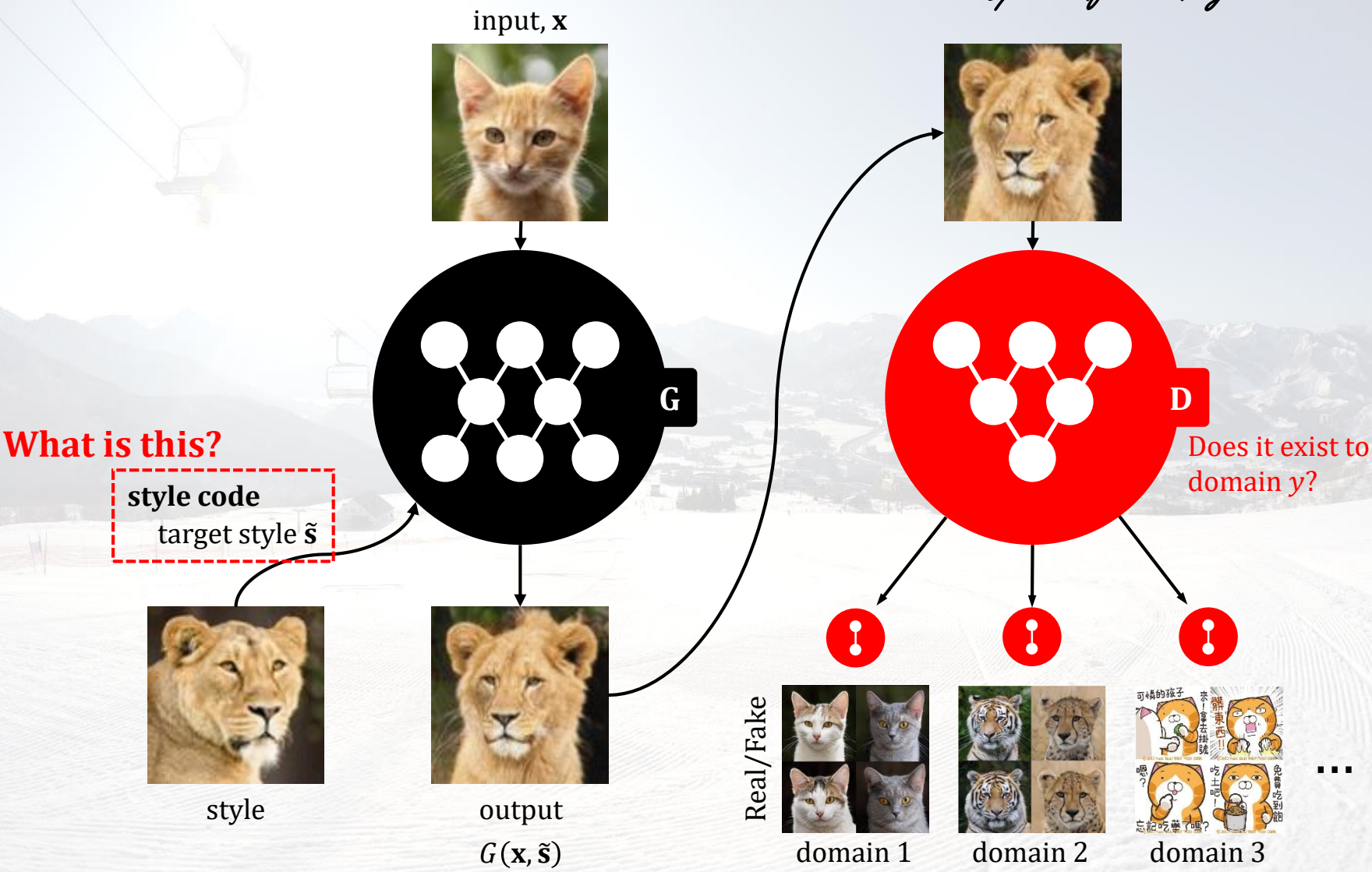
1. Latent-guided image synthesis

2. Reference-guided image synthesis



Ref: Y. Choi, *et al.*, StarGAN v2: Diverse image synthesis for multiple domains. In *CVPR*, 2020.

Overview of StarGAN v2



Ref: Y. Choi, *et al.*, StarGAN v2: Diverse image synthesis for multiple domains. In *CVPR*, 2020.

StarGAN v2: *Mapping network* and *style encoder*

Mapping network

generated by random Gaussian noise

$\mathbf{z}_i$ **Latent code**

$i = 1, 2, 3, \ldots$

$\mathbf{s}_{iy} = F_y(\mathbf{z}_i)$

F

style code in domain 1 $\mathbf{s}_{i1}$

style code in domain 2 $\mathbf{s}_{i2}$

style code in domain 3 $\mathbf{s}_{i3}$

Style encoder

reference image $\mathbf{x}_{ref}$ with known original domain

$\mathbf{s}_y = E_y(\mathbf{x}_{ref})$

E

style code in domain 1 $\mathbf{s}_1$

style code in domain 2 $\mathbf{s}_2$

style code in domain 3 $\mathbf{s}_3$

...

Ref: Y. Choi, *et al.*, StarGAN v2: Diverse image synthesis for multiple domains. In *CVPR*, 2020.

Concept of latent-guided image synthesis

Mapping network

generated by random Gaussian noise

$\mathbf{z}_i$ **Latent code**

$i = 1, 2, 3, \ldots$

$\mathbf{s}_{iy} = F_y(\mathbf{z}_i)$

F

style code in domain 1 $\mathbf{s}_{i1}$

style code in domain 2 $\mathbf{s}_{i2}$

style code in domain y $\mathbf{s}_{iy}$

randomly selected a style code of domain y as the target style $\tilde{\mathbf{s}}$

style code

target style $\tilde{\mathbf{s}}$

no reference in this case

input, **x**

G

output $G(\mathbf{x}, \tilde{\mathbf{s}})$

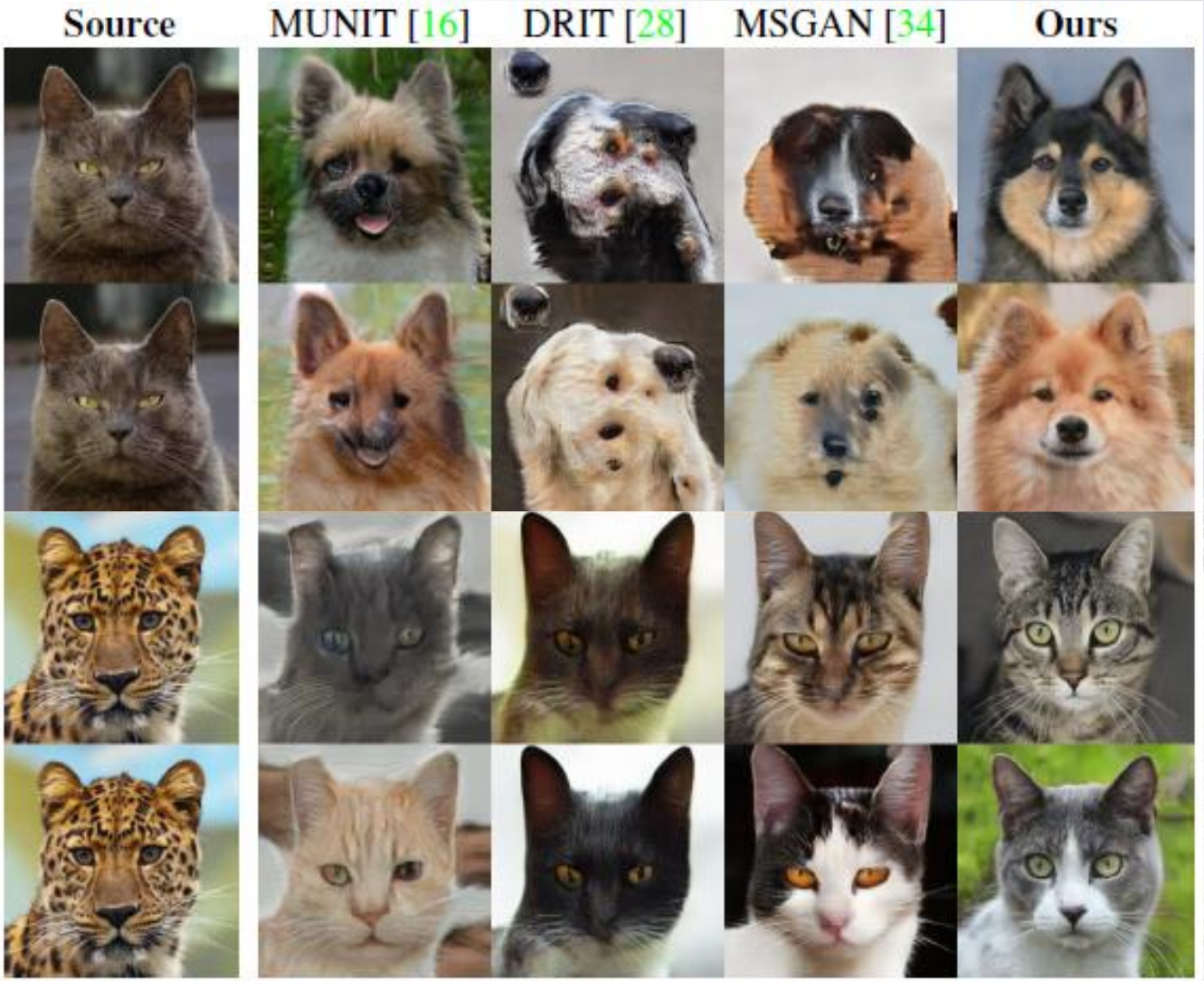
domain y

D

Real or Fake?

Ref: Y. Choi, *et al.*, StarGAN v2: Diverse image synthesis for multiple domains. In *CVPR*, 2020.

Latent-guided image synthesis results



Ref: Y. Choi, *et al.*, StarGAN v2: Diverse image synthesis for multiple domains. In *CVPR*, 2020.

Concept of reference-guided image synthesis

Style encoder

reference image $\mathbf{x}_{ref}$ with known original domain

$\mathbf{s}_y = E_y(\mathbf{x}_{ref})$

E

encoding the reference image into a style code of domain y as the target style $\tilde{\mathbf{s}}$

style code in domain 1 $\mathbf{s}_1$

style code in domain 2 $\mathbf{s}_2$

style code in domain 3 $\mathbf{s}_3$

...

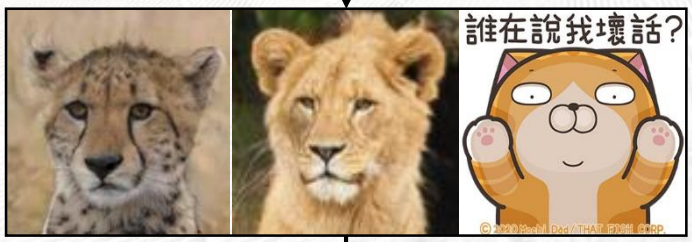
style code

target style $\tilde{\mathbf{s}}$

input, $\mathbf{x}$

G

output $G(\mathbf{x}, \tilde{\mathbf{s}})$



$G(\mathbf{x}, \mathbf{s}_1)$ $G(\mathbf{x}, \mathbf{s}_2)$ $G(\mathbf{x}, \mathbf{s}_3)$

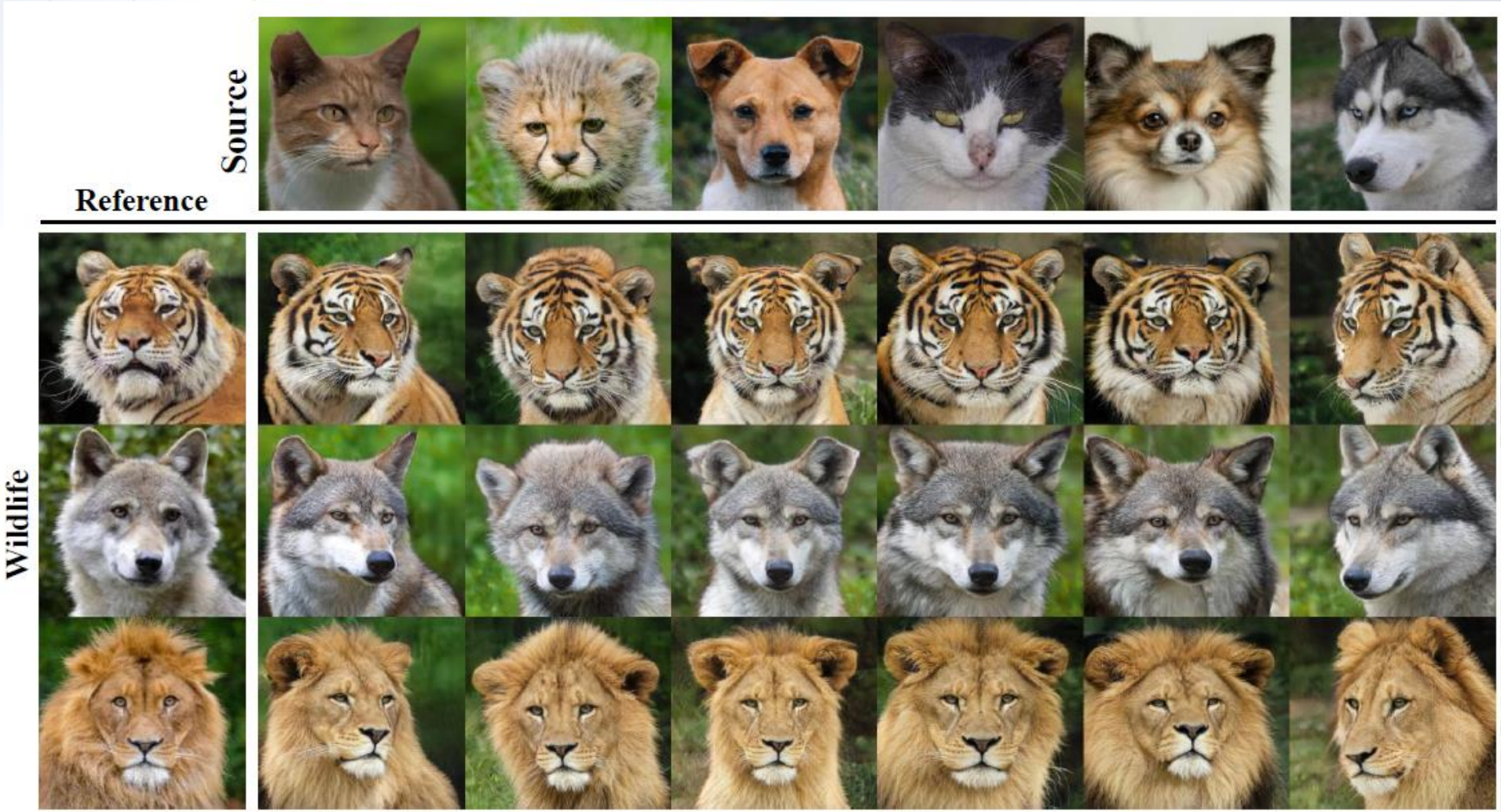
D Real or Fake?

Ref: Y. Choi, *et al.*, StarGAN v2: Diverse image synthesis for multiple domains. In *CVPR*, 2020.

Reference-guided image synthesis results (1/3)

Ref: Y. Choi, *et al.*, StarGAN v2: Diverse image synthesis for multiple domains. In *CVPR*, 2020.

Reference-guided image synthesis results (2/3)



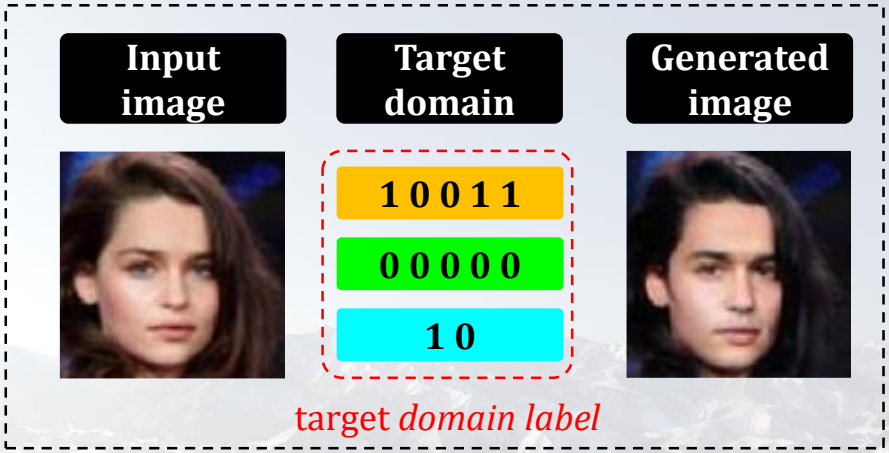
Ref: Y. Choi, *et al.*, StarGAN v2: Diverse image synthesis for multiple domains. In *CVPR*, 2020.

Reference-guided image synthesis results (3/3)

Ref: Y. Choi, *et al.*, StarGAN v2: Diverse image synthesis for multiple domains. In *CVPR*, 2020.

Summary

- StarGAN v1:
  - Multi-domain image translation
  - Single generator
  - The idea of domain label
  - Mask vector
  - Lack of domain diversity



- StarGAN v2:
  - Multi-domain image translation
  - Single generator
  - Diversity of each domain
  - The idea of style code
  - Mapping network and style encoder

Thank you!

Please feel free to contact me if you have any question or comment.

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