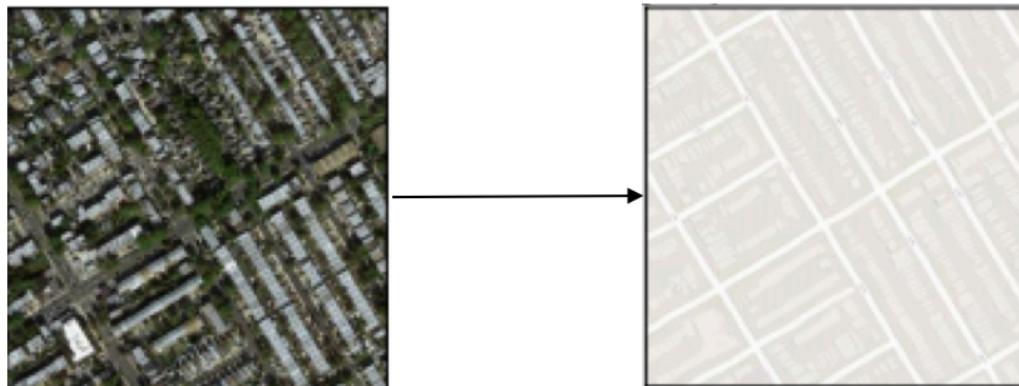


Cycle GAN: Unpaired Image-to-image Translation

Zhaokai Huang

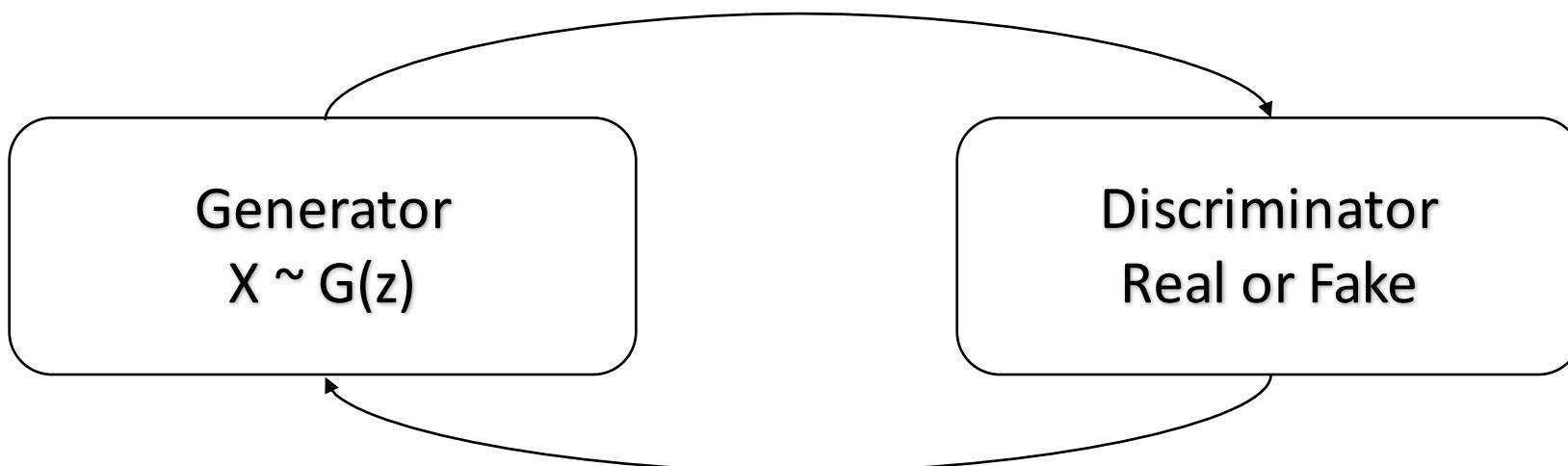


Roadmap

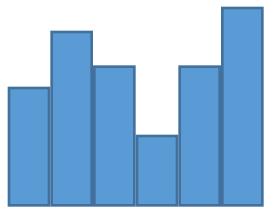
- Recap
- Image-to-image Translation
- Conditional GAN
- Cycle GAN
 - ...
- Directions

Recap

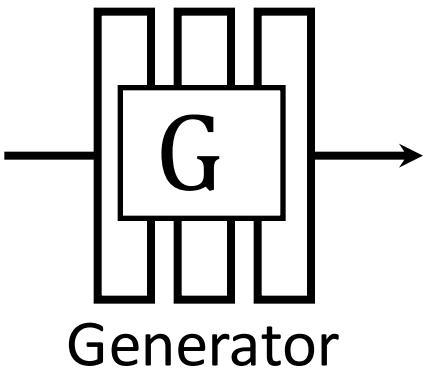
- Generative Adversarial Networks (GANs)

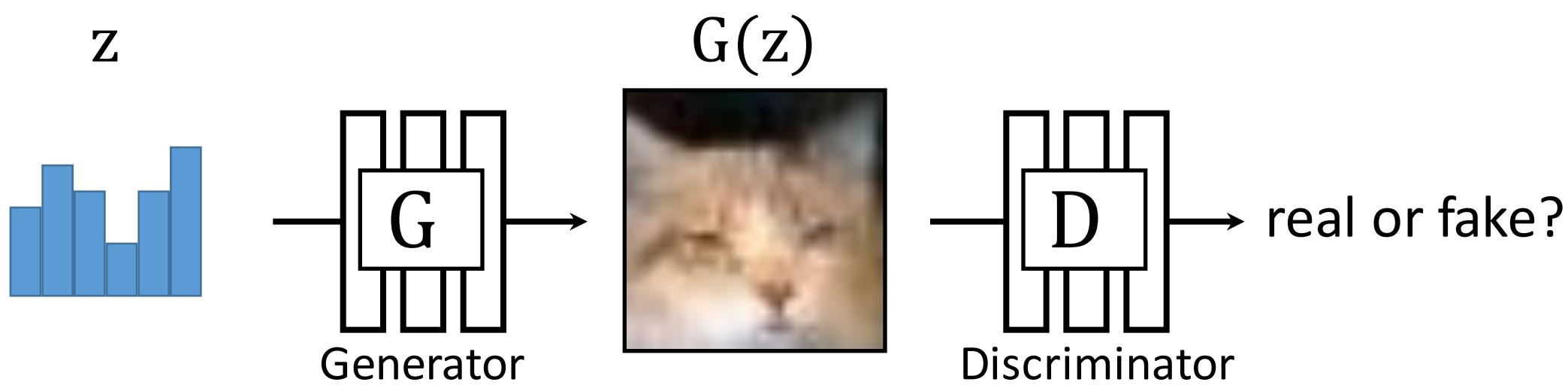


z



$G(z)$





G : generate fake samples that can fool D

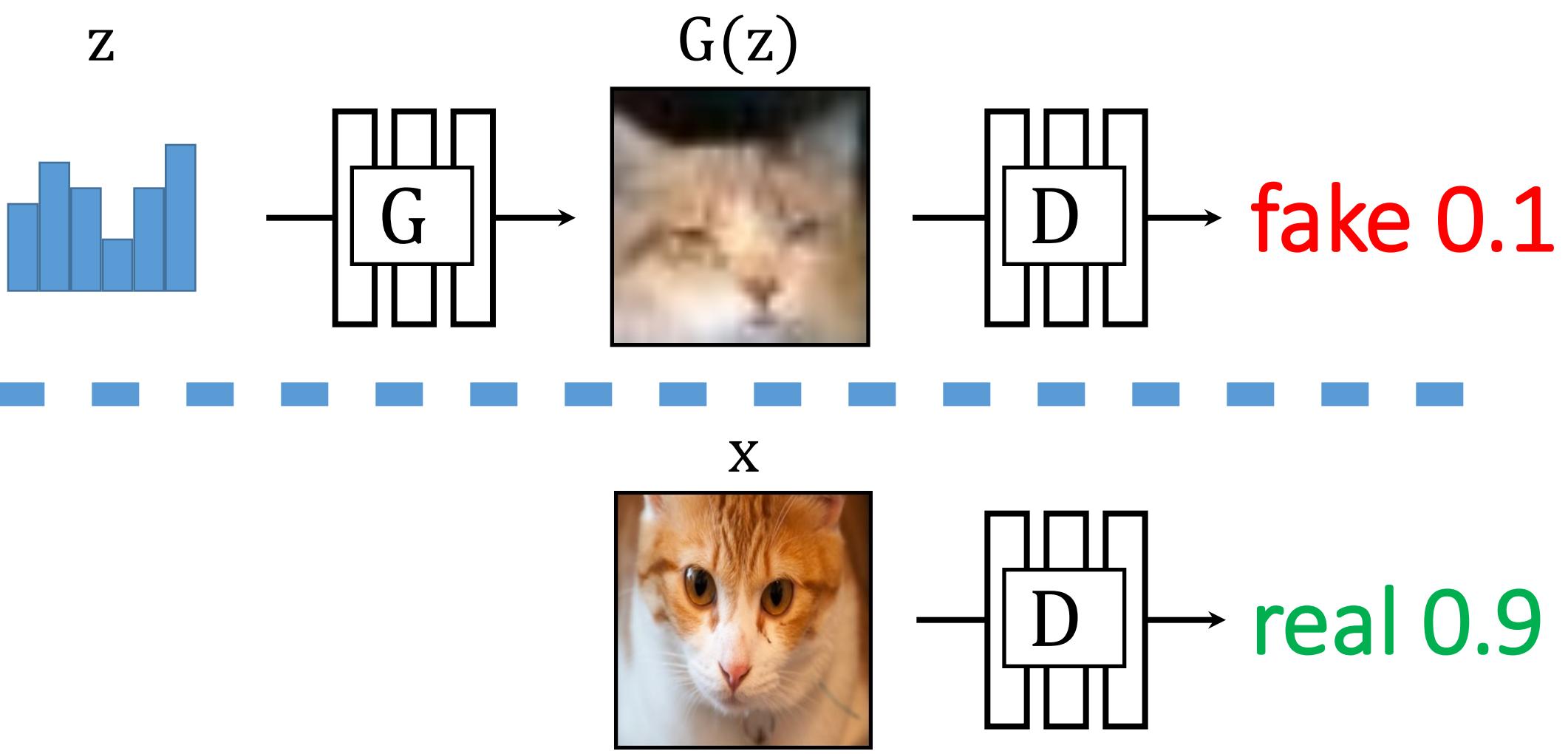
D : classify fake samples vs. real images

z

$G(z)$



$$\min_G \max_D V(D, G) = \mathbb{E}_{\mathbf{x} \sim p_{\text{data}}(\mathbf{x})} [\log D(\mathbf{x})] + \mathbb{E}_{\mathbf{z} \sim p_{\mathbf{z}}(\mathbf{z})} \boxed{\log(1 - D(G(\mathbf{z})))}$$



$$\min_G \max_D V(D, G) = \mathbb{E}_{\mathbf{x} \sim p_{\text{data}}(\mathbf{x})} [\log D(\mathbf{x})] + \mathbb{E}_{\mathbf{z} \sim p_{\mathbf{z}}(\mathbf{z})} [\log(1 - D(G(\mathbf{z})))]$$

DCGAN Example

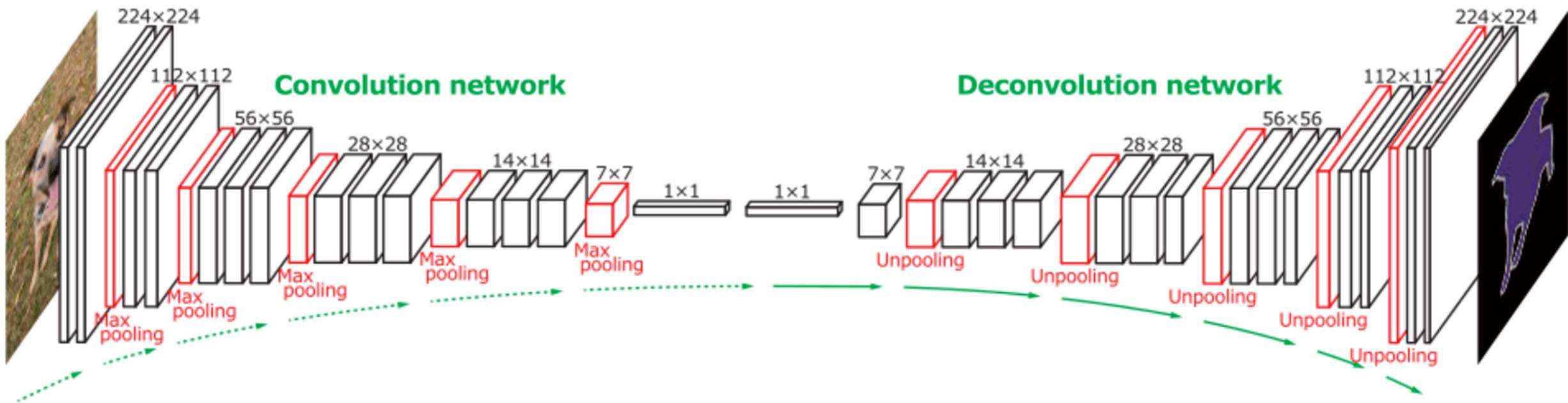


Image-to-Image Translation

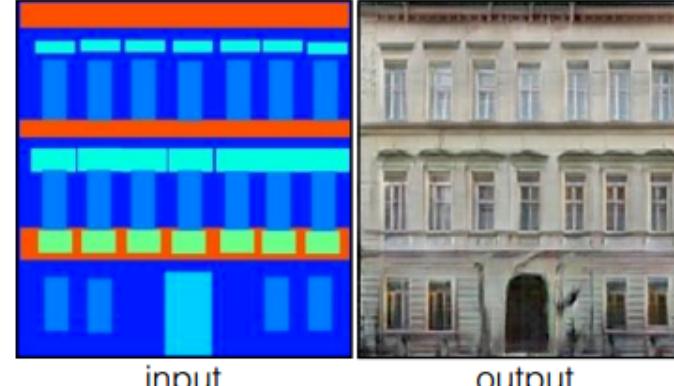
Labels to Street Scene



input

output

Labels to Facade



input

output

BW to Color



input

output

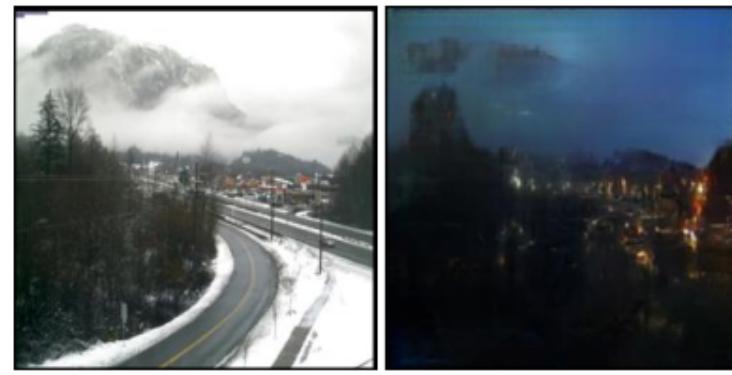
Aerial to Map



input

output

Day to Night



input

output

Edges to Photo

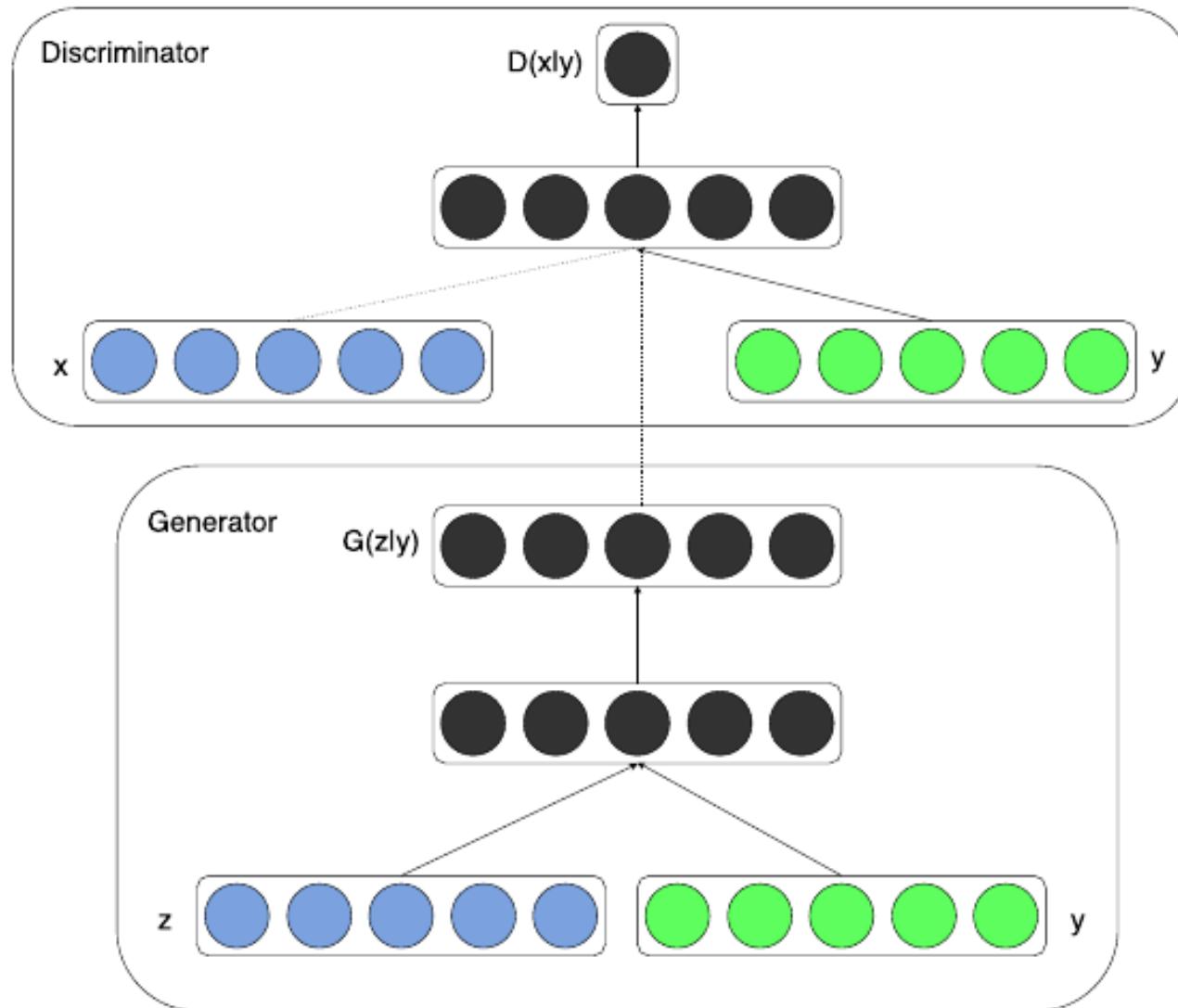


input

output

Image-to-image translation with conditional adversarial nets [Isola, Zhu, Zhou, Efros. CVPR 2017]

Conditional GAN

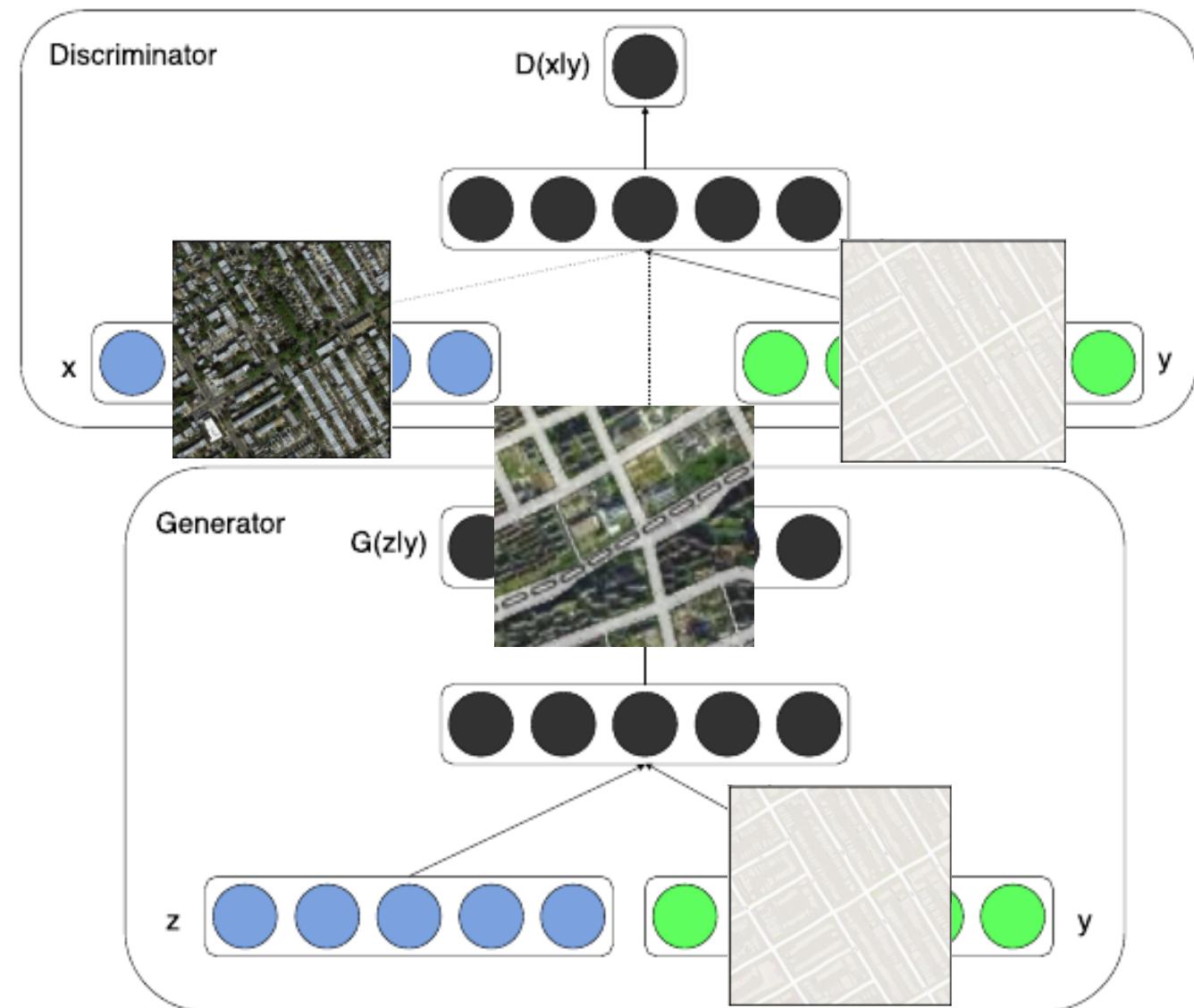




Input (y)
Conditional features



Output ($G(z|y)$)

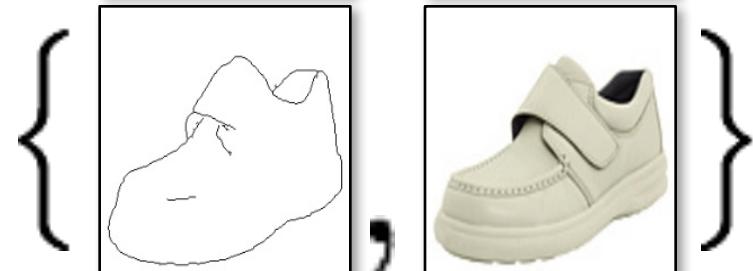
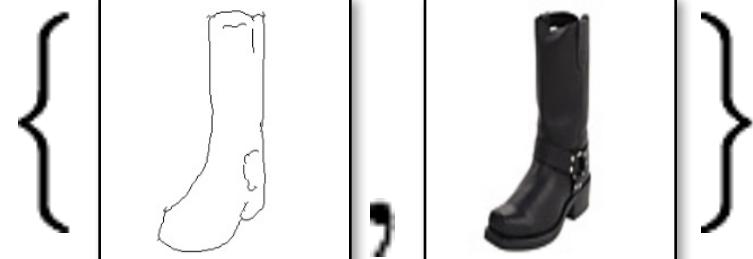


Cycle GAN

Paired

x_i

y_i

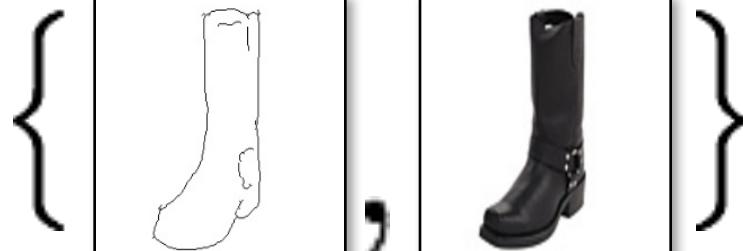


•
•
•

Paired

x_i

y_i



•
•
•

Unpaired

X



•
•
•

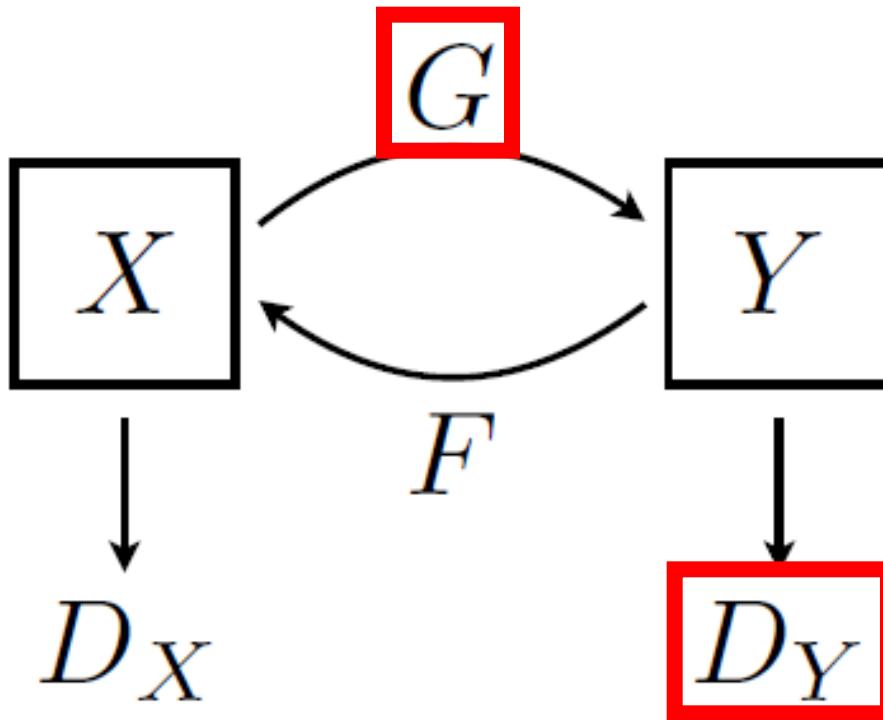
Y



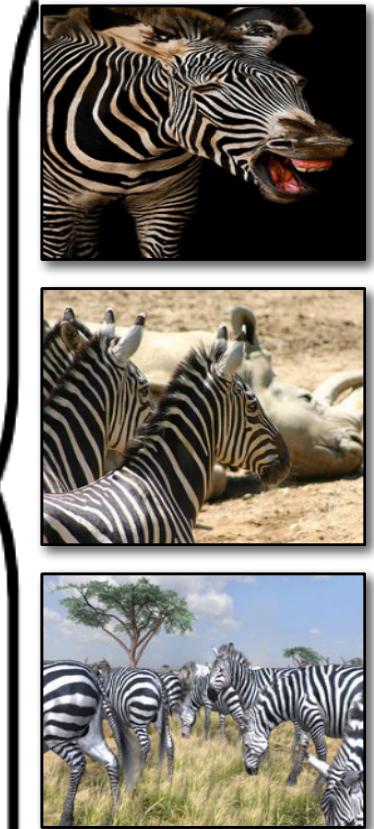
•
•
•

Unpaired Image-to-image translation using cycle-consistent adversarial networks

X



Y



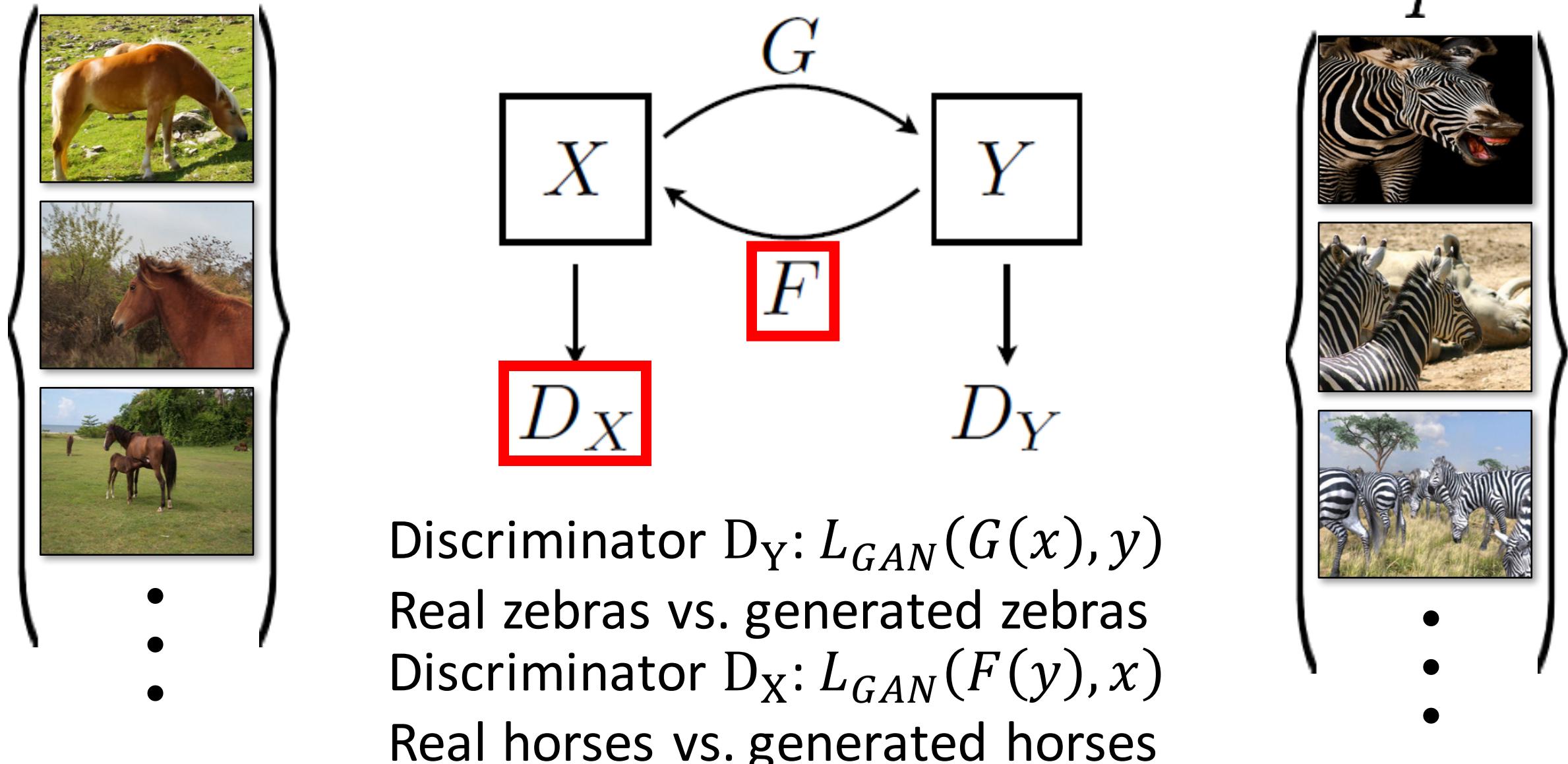
Discriminator D_Y : $L_{GAN}(G(x), y)$
Real zebras vs. generated zebras

•
•
•

•
•
•

[Zhu*, Park*, Isola, Efros on arxiv]

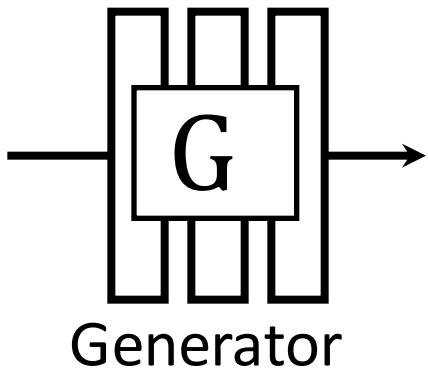
Unpaired Image-to-image translation using cycle-consistent adversarial networks



x



$G(x)$



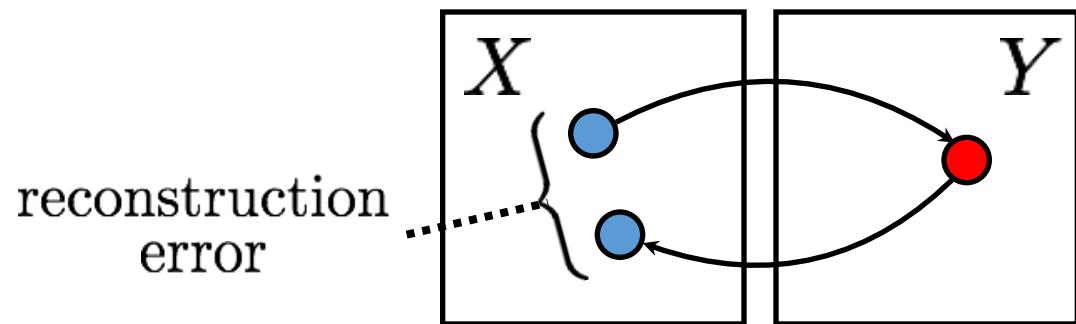
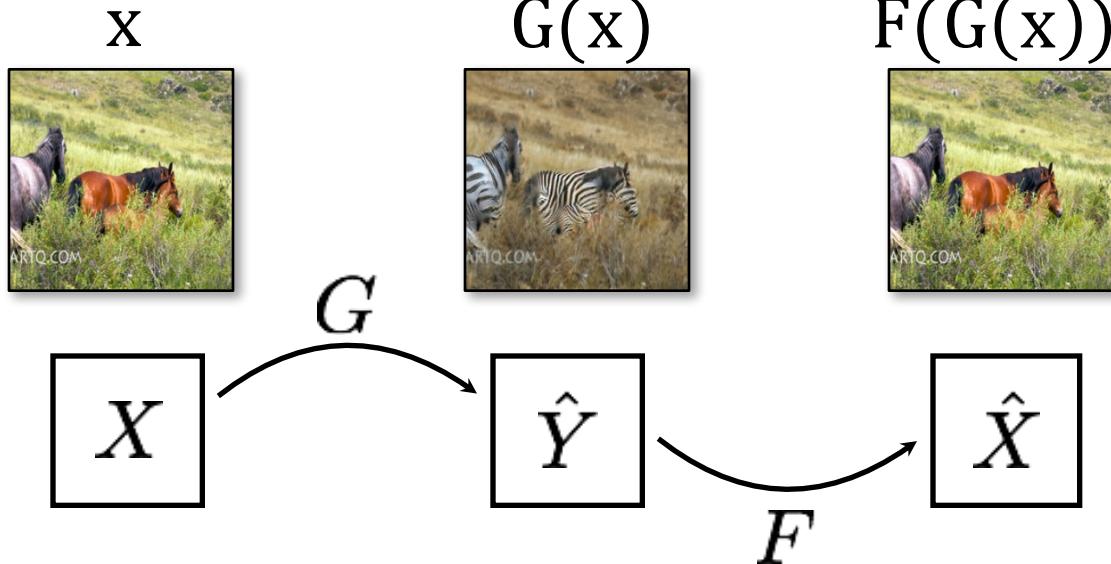
Real!



N mapping functions,
N possible results.

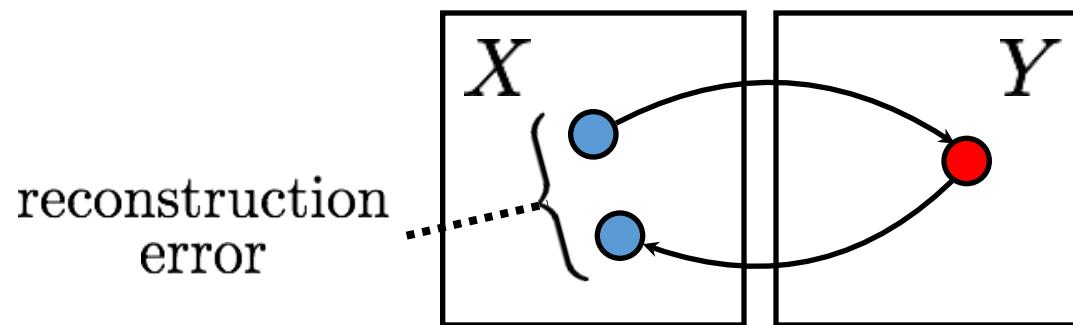
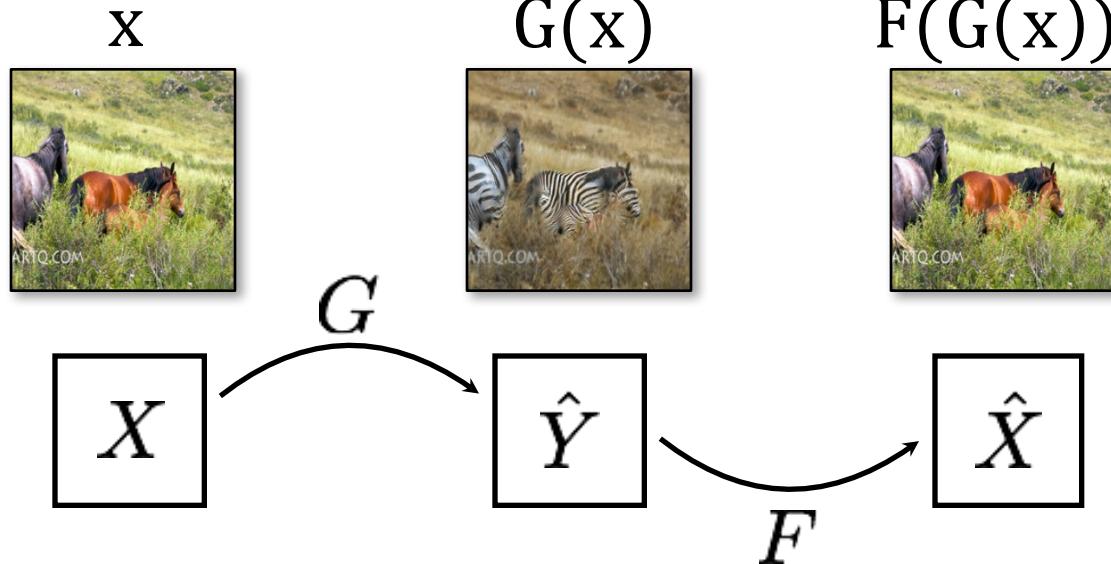
Cycle-consistency Loss

Forward cycle loss: $\|F(G(x)) - x\|_1$



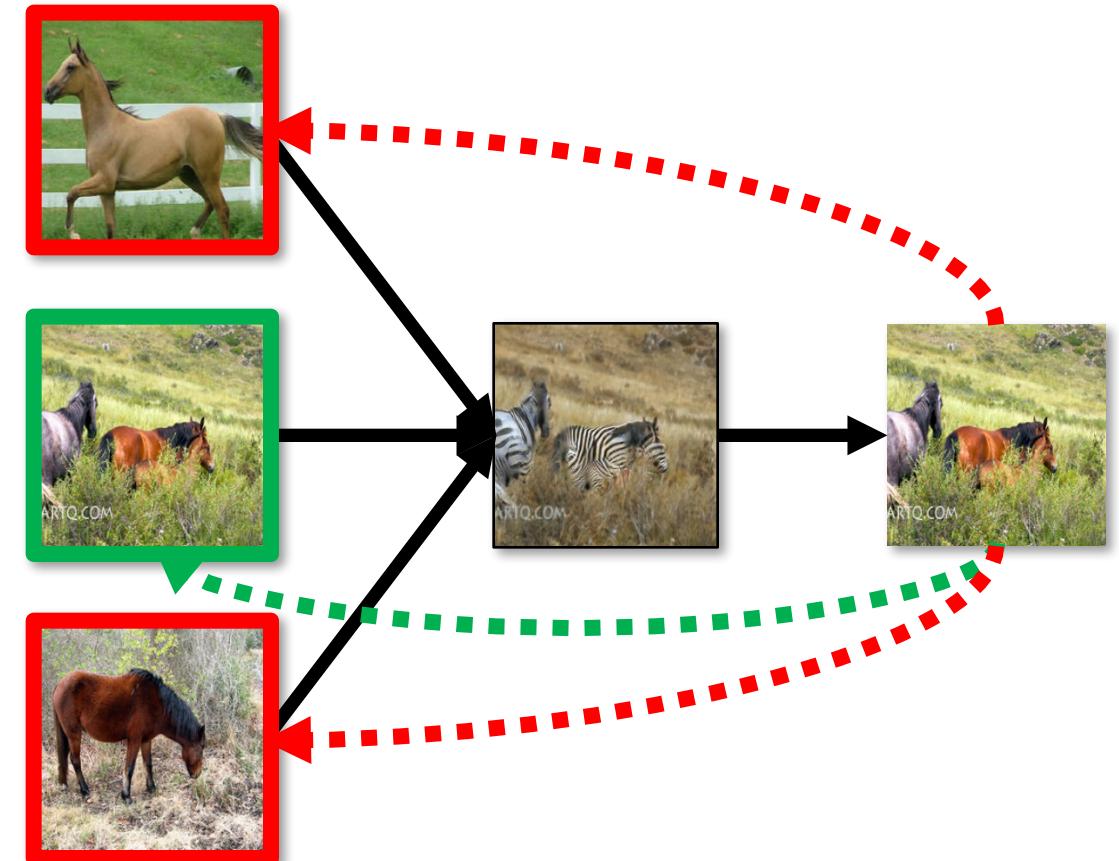
Cycle-consistency Loss

Forward cycle loss: $\|F(G(x)) - x\|_1$



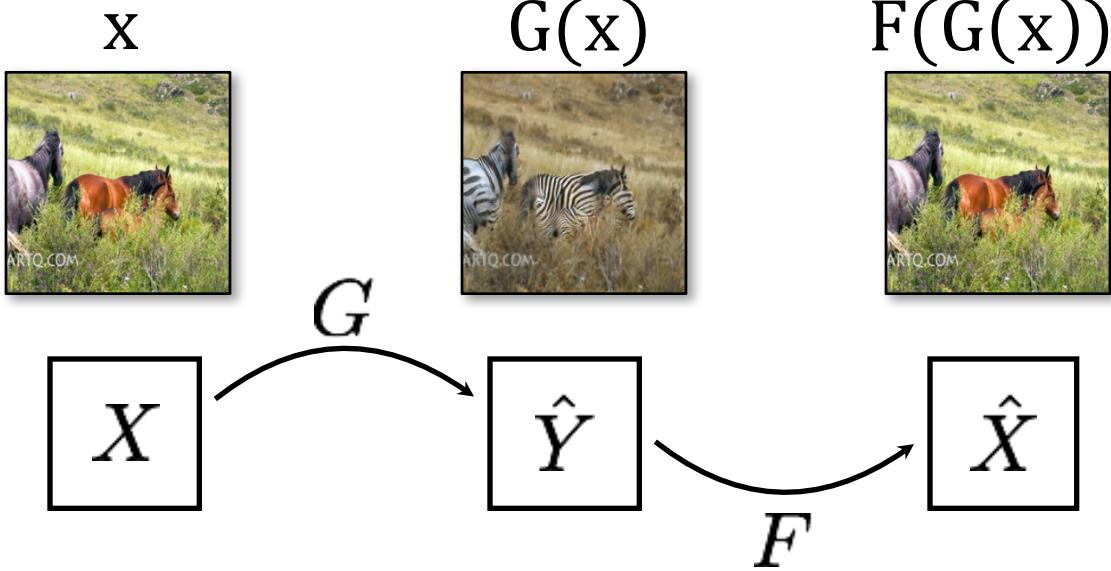
reconstruction
error

Sample cycle loss

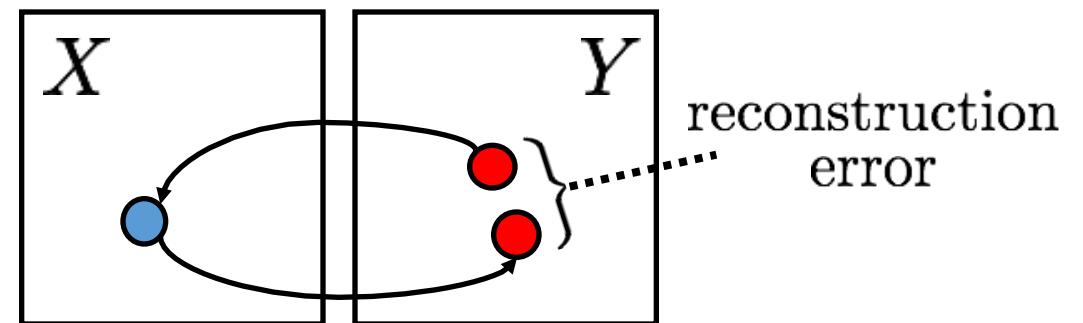
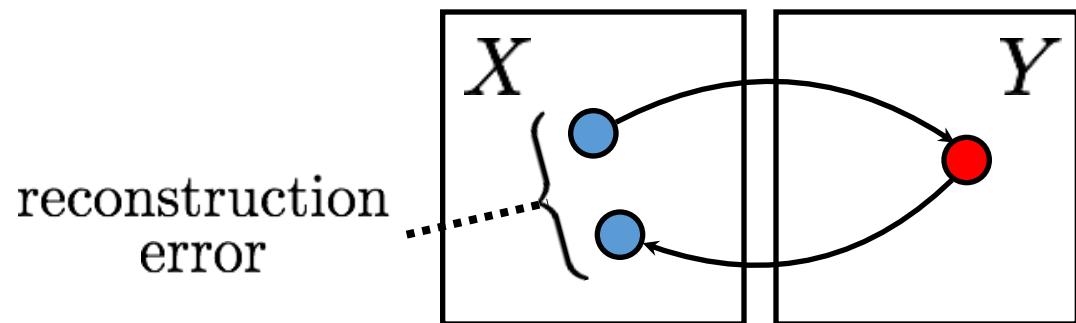
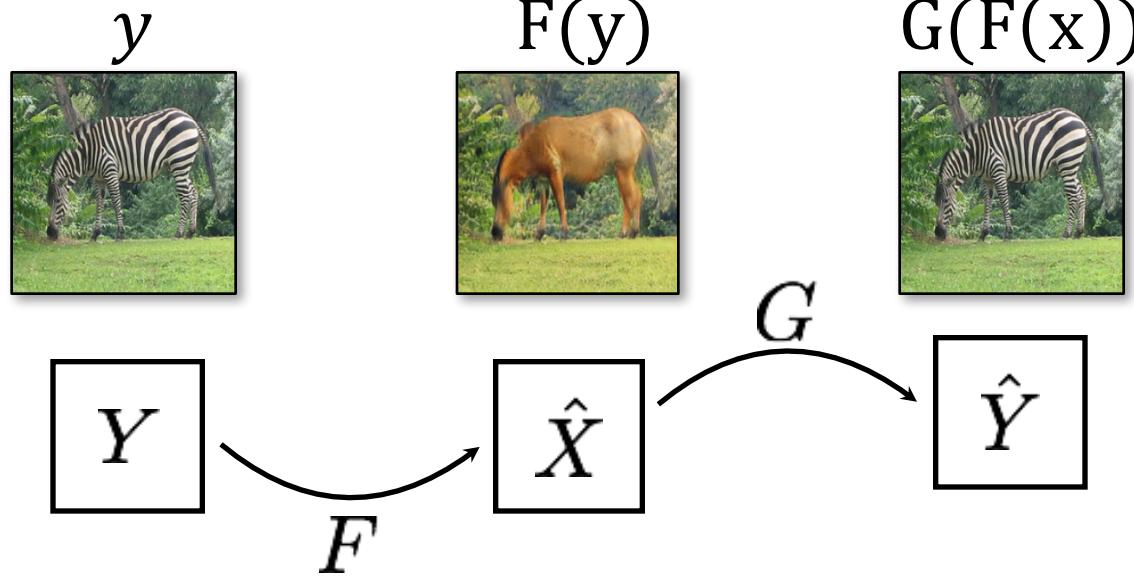


Cycle-consistency Loss

Forward cycle loss: $\|F(G(x)) - x\|_1$



Backward cycle loss: $\|G(F(y)) - y\|_1$



Objective Function

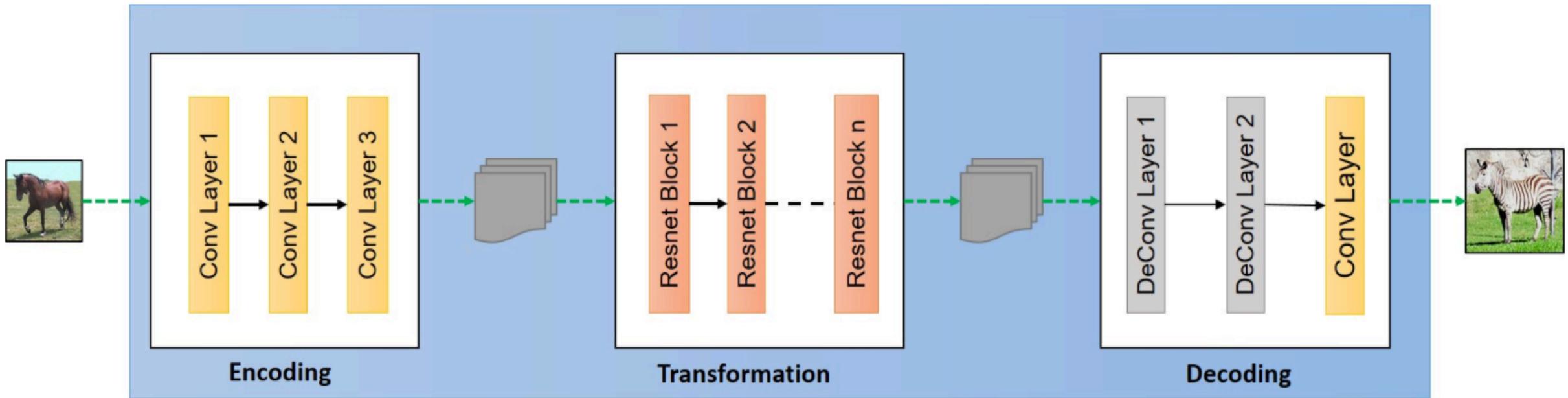
Cycle Loss,

$$\begin{aligned}\mathcal{L}_{\text{cyc}}(G, F) = & \mathbb{E}_{x \sim p_{\text{data}}(x)} [\|F(G(x)) - x\|_1] \\ & + \mathbb{E}_{y \sim p_{\text{data}}(y)} [\|G(F(y)) - y\|_1].\end{aligned}$$

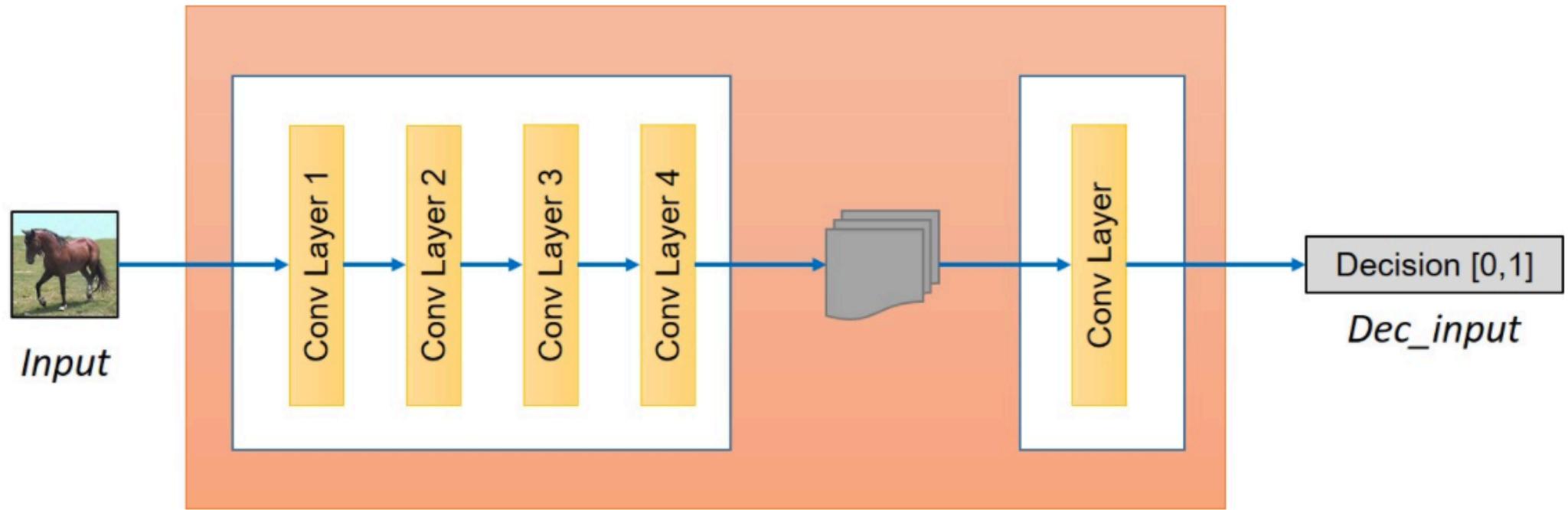
Full Objective,

$$\begin{aligned}\mathcal{L}(G, F, D_X, D_Y) = & \mathcal{L}_{\text{GAN}}(G, D_Y, X, Y) \\ & + \mathcal{L}_{\text{GAN}}(F, D_X, Y, X) \\ & + \lambda \mathcal{L}_{\text{cyc}}(G, F),\end{aligned}$$

Architecture - generator



Architecture - discriminator



Applications

Input



Output



horse → zebra



zebra → horse

Input



Monet



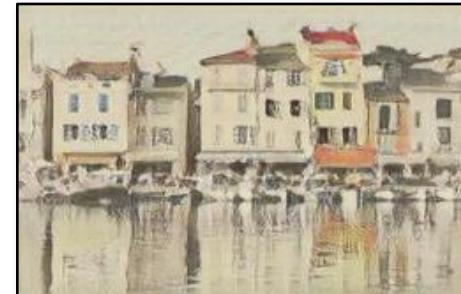
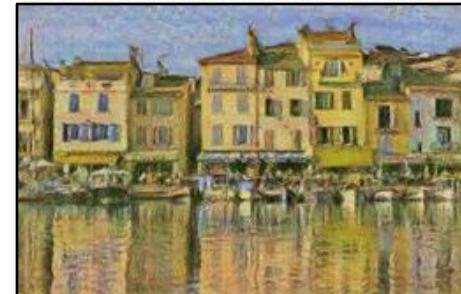
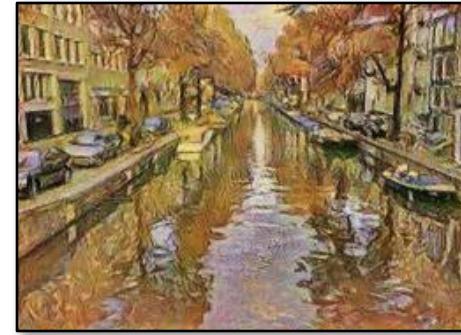
Van Gogh



Cezanne



Ukiyo-e





Directions

- Imitation Learning
- Neural Dialogue Generation
- IRGAN (Information Retrieve, Alibaba)

Thanks! Q&A?