Welcome to Part GANs 2

Hope you enjoyed working with MNIST once again

How many of you have been able to generate MNIST digits?

- Show of hands

Let’s clear up some things

- I’ll explain Vanilla GAN again.

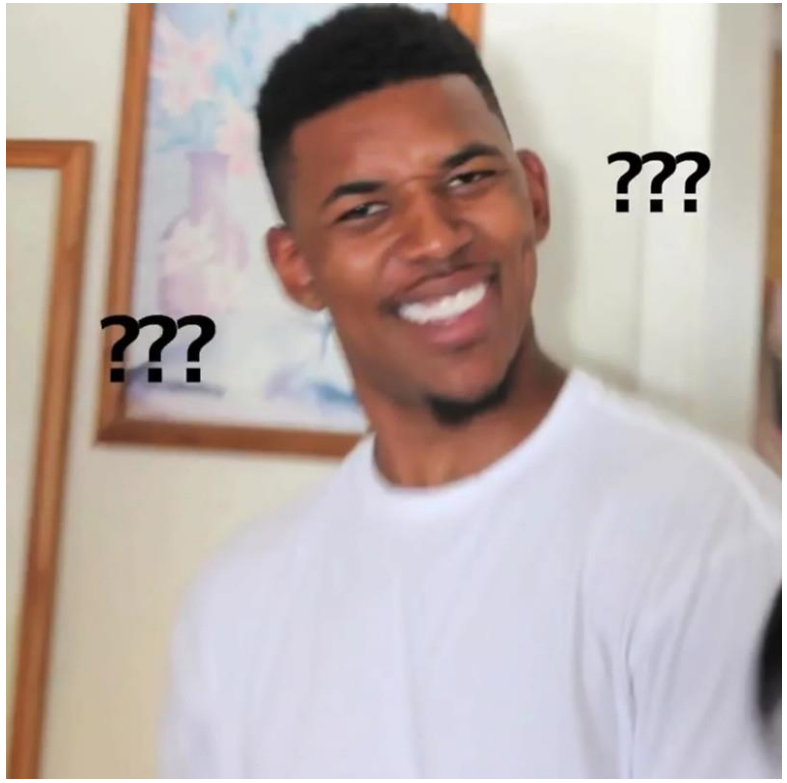
$$\min_G \max_D V(D,G) = \mathbb{E}_{\boldsymbol{x}\sim p_{\text{data}}(\boldsymbol{x})}[\log D(\boldsymbol{x})] + \mathbb{E}_{\boldsymbol{z}\sim p_{\boldsymbol{z}}(\boldsymbol{z})}[\log(1 - D(G(\boldsymbol{z})))].$$

For G → Rather than training G to minimize $\log(1 - D(G(z)))$ we can train G to maximize $\log D(G(z))$.

Latent space interpolations

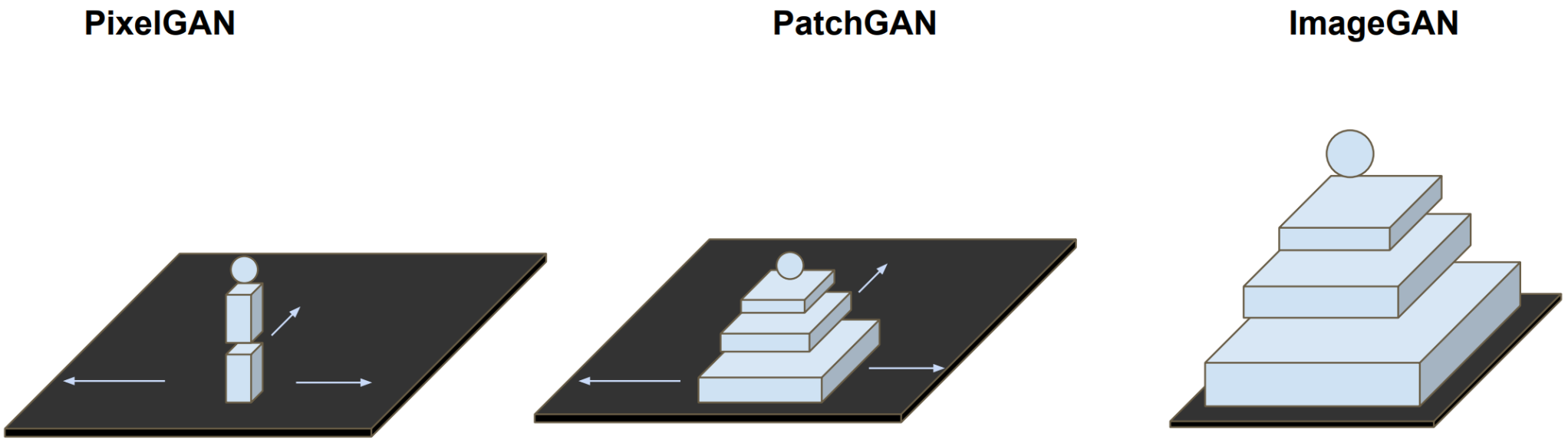
Your assignment

- Implement a CycleGAN and use it to convert horses to zebras
- Wait, what's that and how do I do it?



PatchGAN

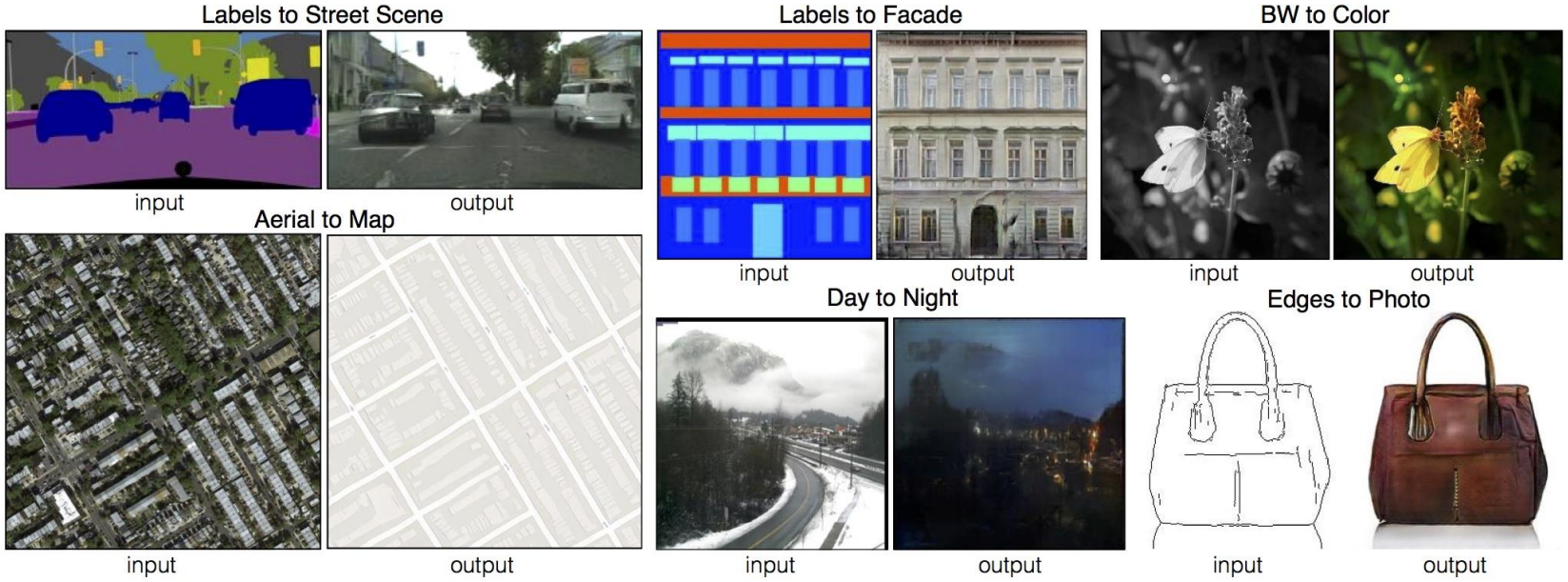
- Instead of creating one classification for the entire image, classify smaller areas of the image in a sliding window fashion.
  - Forces generator/discriminator to be good at all parts of the image



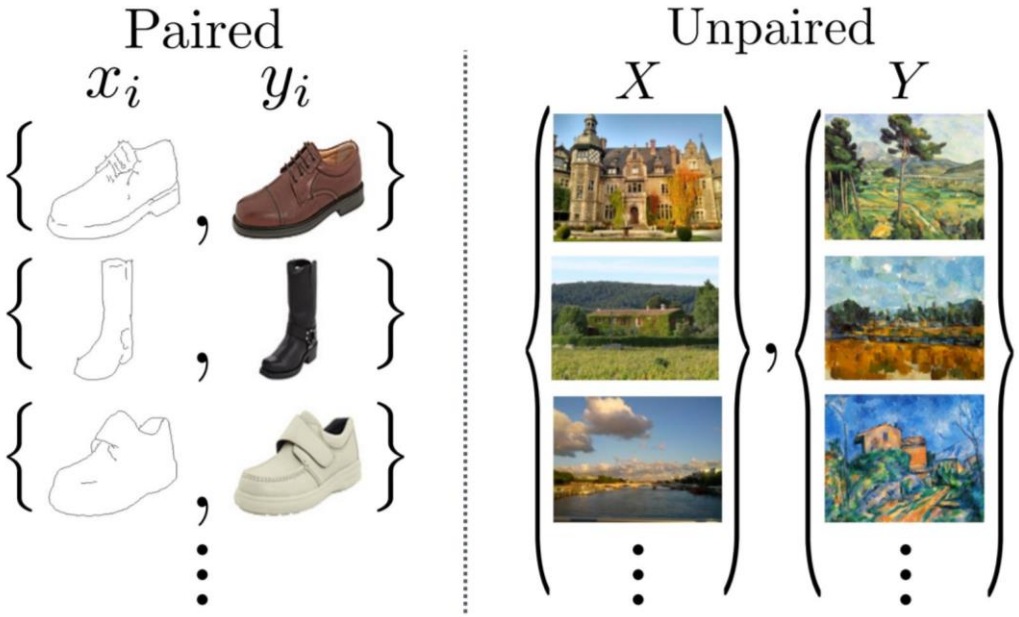
Pix2pix

Isola et al. *Image-to-Image Translation with Conditional Adversarial Networks*

- Domain-transfer (converting image from one modality to another)
  - Requires paired training examples
- Uses U-net style architecture
- https://affinelayer.com/pixsrv/



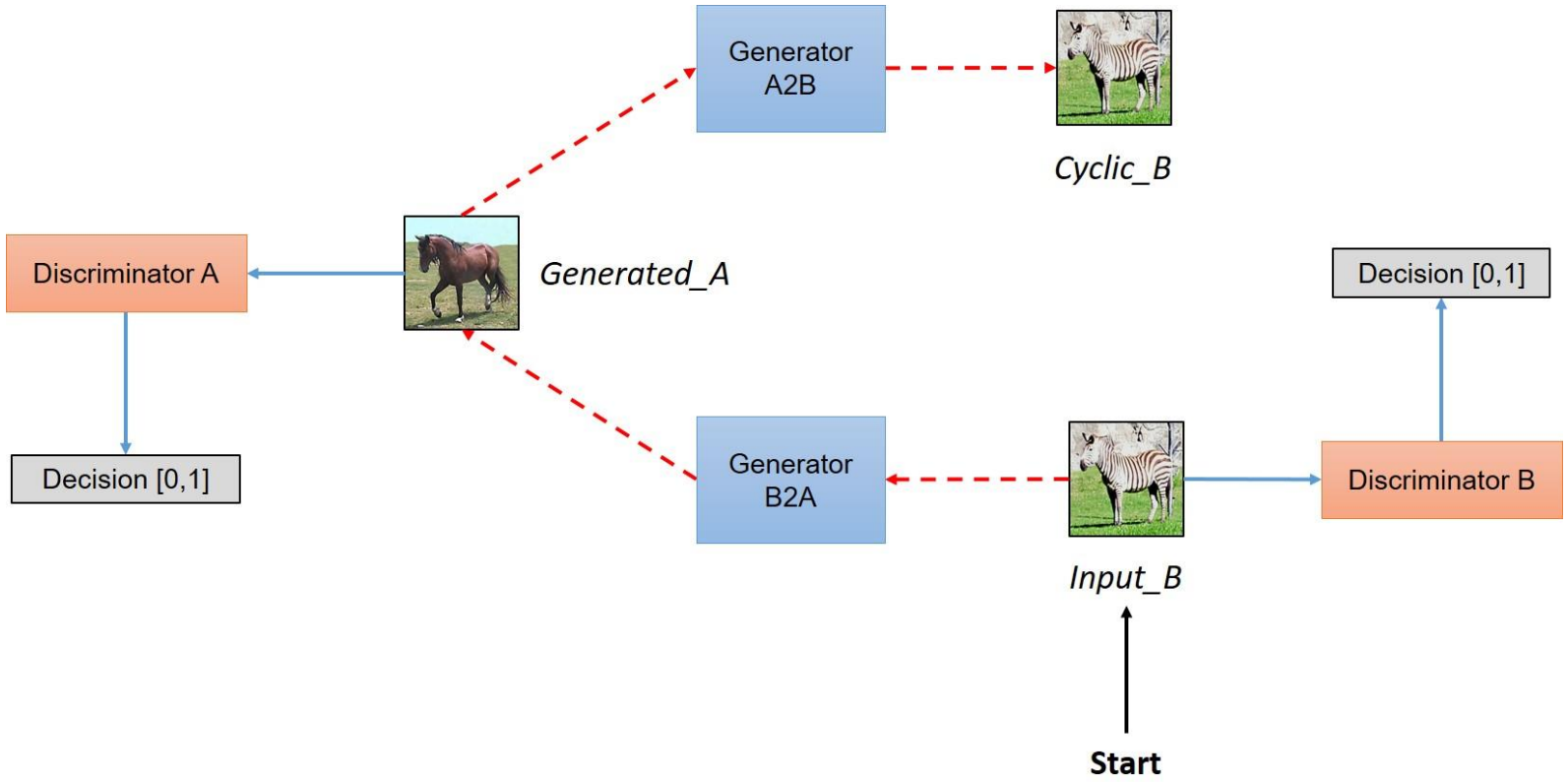
What if we don’t have paired training examples?



CycleGAN

Zhu et al. *Unpaired Image-to-Image Translation using Cycle-Consistent Adversarial Networks*

- Doesn't require paired training examples
  - Having images from each of the two classes is enough



CycleGAN losses overview

```
b_fake = A2B(a_real)
a_rec  = B2A(b_fake)
a_fake = B2A(b_real)
b_rec  = A2B(a_fake)
```

- Generator losses

```
GANloss(D_B(b_fake), 1)          Fool discriminator
GANloss(D_A(a_fake), 1)
ImLoss(a_rec, a_real)            Cycle Consistency
ImLoss(b_rec, b_real)
ImLoss(B2A(a_real), a_real)      Identity loss
ImLoss(A2B(b_real), b_real)
```

L1/L2

- Discriminator losses

```
GANloss(D_A(a_real), 1)
GANloss(D_B(b_real), 1)
GANloss(D_A(a_fake), 0)
GANloss(D_B(b_fake), 0)
```

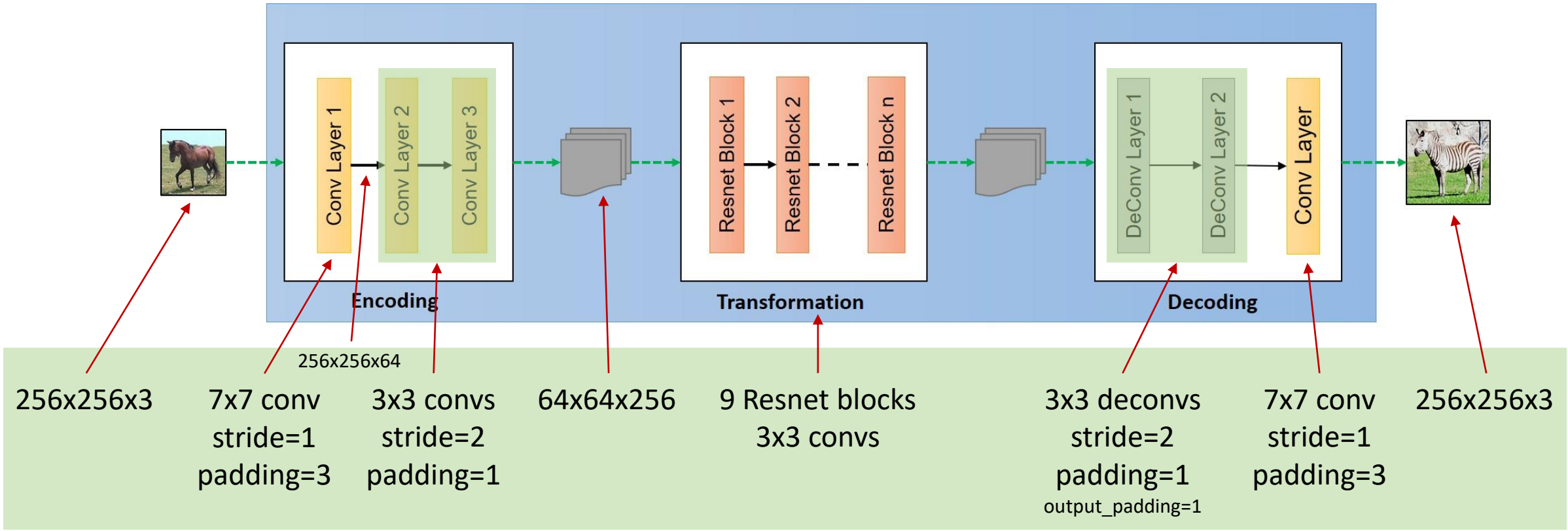
GAN/WGAN/LSGAN/what you prefer

Please look at these cool images ☺
Generated by https://nvlabs.github.io/FUNIT/petswap.html

1, Input
2, Otter Hound
3, Maltese
4, Norwegian Elkhound
5, Shih-Tzu
6, Curly-coated Retriever
7, Labrador Retriever
8, Irish Water Spaniel
9, Maned Wolf
10, Newfoundland Dog
11, Tabby Cat
12, Affenpinscher
13, Cheetah
14, Grey Wolf
15, Grey fox
16, Lynx

CycleGAN architecture

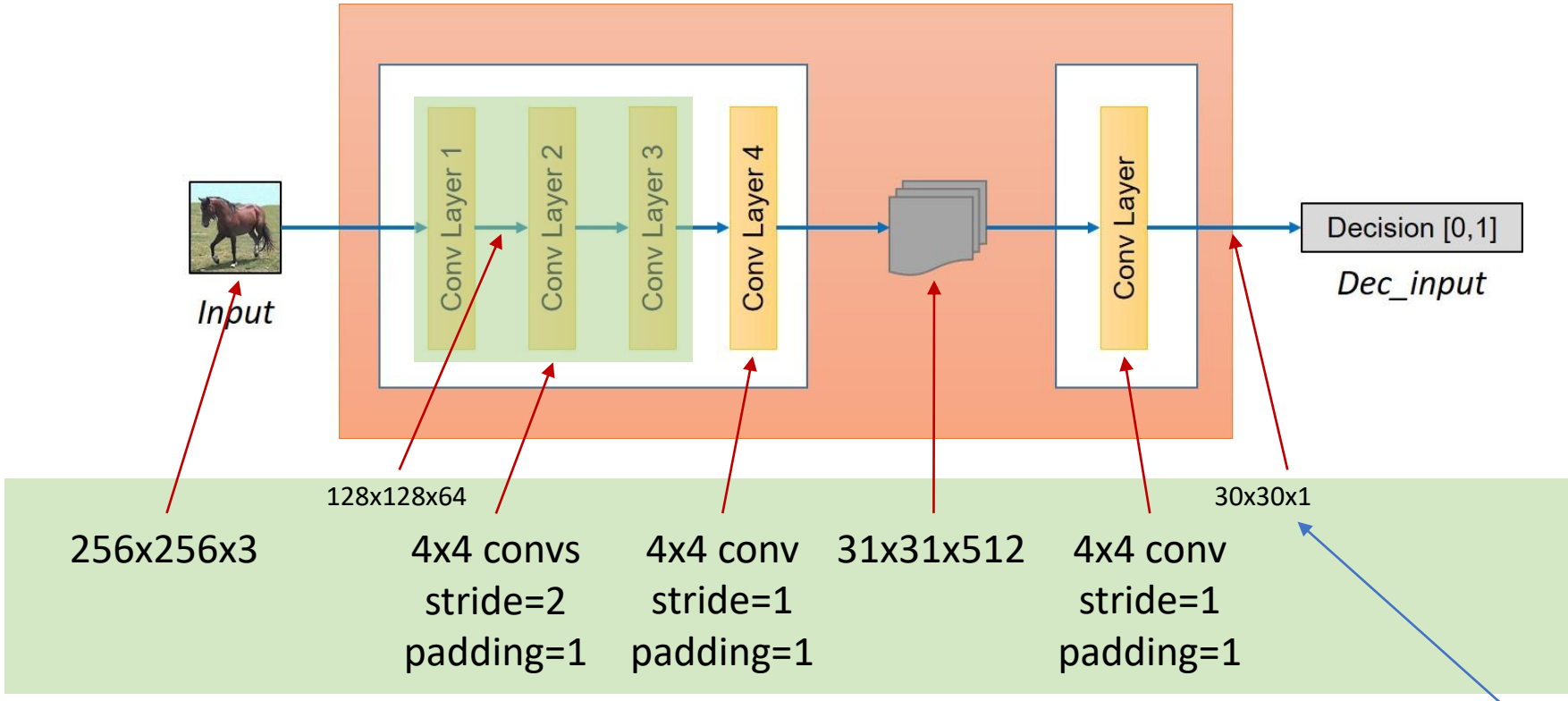
- Generator



Architecture and values are only suggestions (that should work)

CycleGAN architecture

- Discriminator



Architecture and values are only suggestions (that should work)

CycleGAN architecture

- ReLU in G
- LeakyReLU in D ($\alpha = 0.2$)
- Instance normalization after all (Leaky)ReLUs
- Double or halve number of features after each conv/deconv

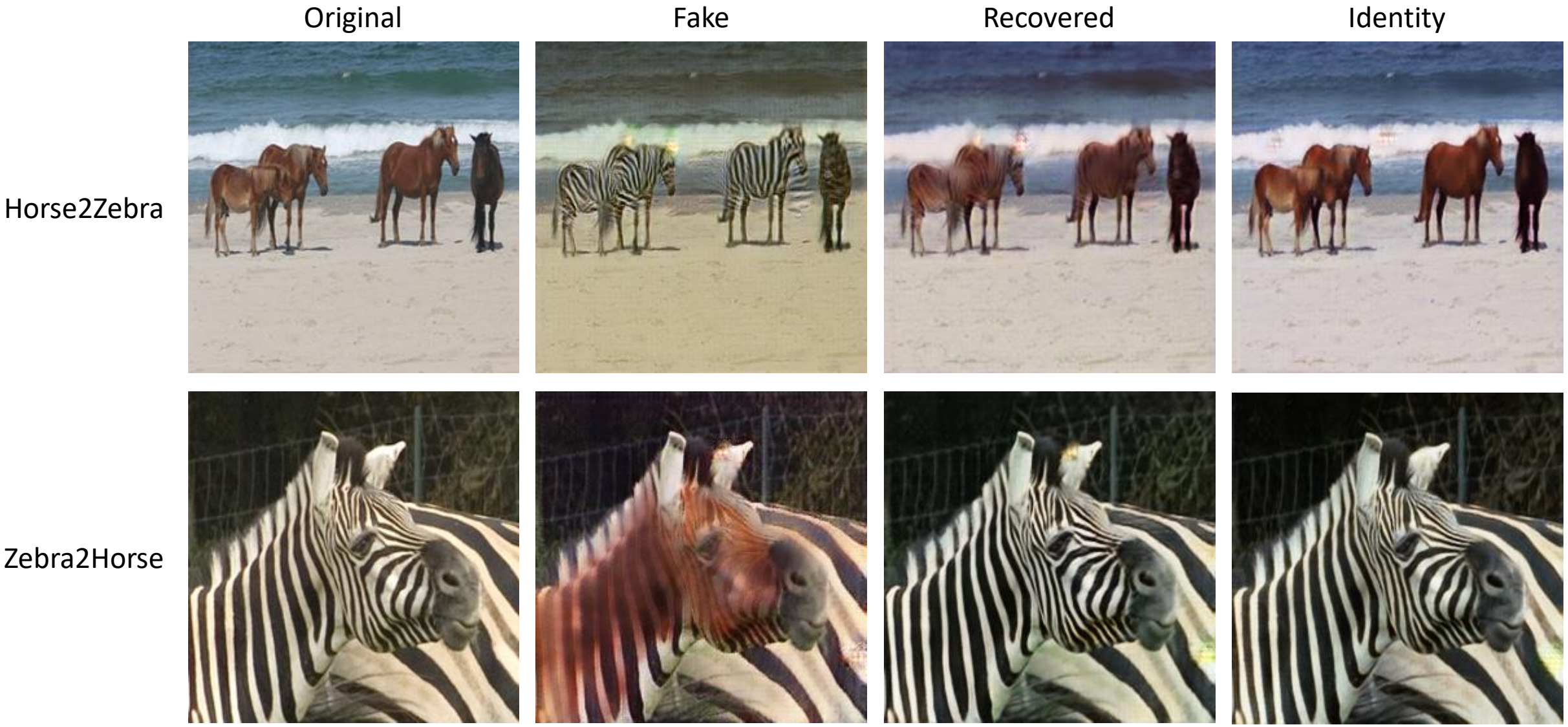
CycleGAN training

- Images are quite big
  - Batch size 1
- Adam $\beta_1 = 0.5$, learning rate = 0.0002
  - Default parameter of $\beta_1 = 0.9$ doesn't work well
- $\lambda_{cycle} = 10$
- $\lambda_{identity} = 0.5$
- LSGAN loss
- Remember data augmentation

CycleGAN

- All of these hyperparameters are just suggestions that have worked out well for other people.
- Often you will not have the advantage of knowing good numbers beforehand, but the time for the assignment is short

My example results (approx 30 epochs)



CycleGAN – Failure case

- No horses with riders in the training data -> failure

Training GANs is hard!

Experiments Result
they show in papers

Experiments Result
you try to reproduce

Advanced tips

- Save checkpoints of your models and mix in older versions of the generator and discriminator every couple of generations

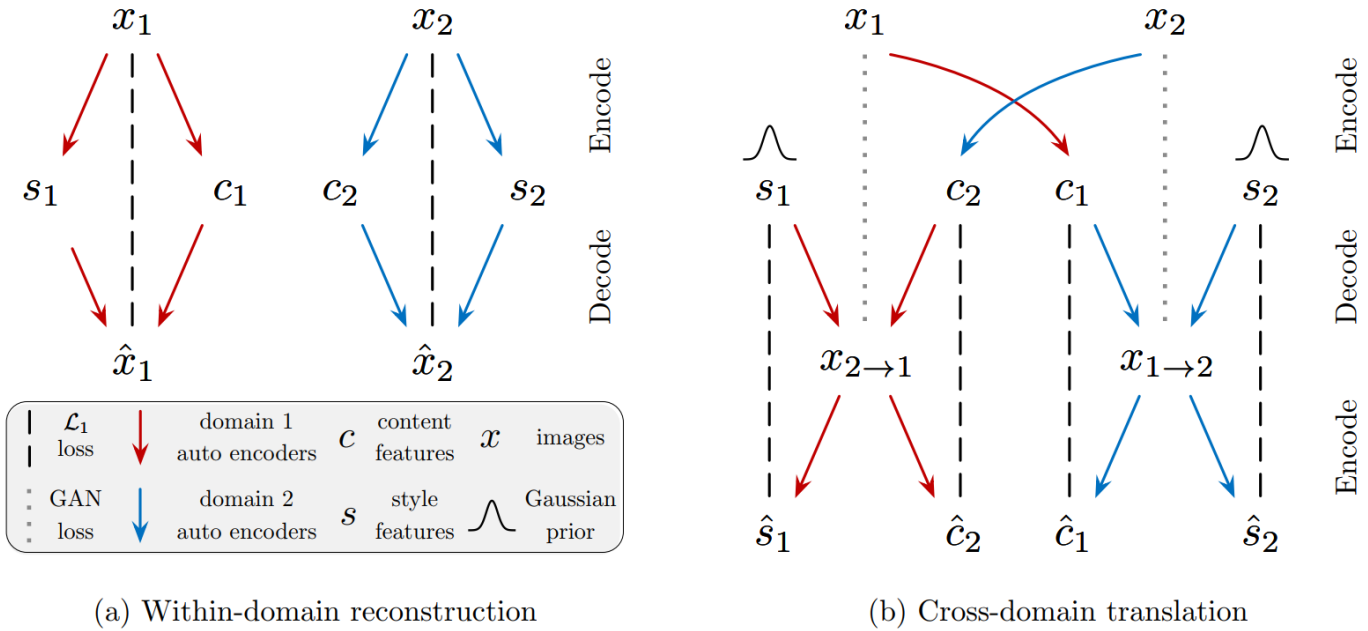
Is CycleGAN the best?

- CycleGAN has trouble with images requiring larger spatial changes
- Cycle consistency is very strong constraint (too strong?)
- But still tried and true!

MUNIT

Huang et al. *Multimodal Unsupervised Image-to-Image Translation*

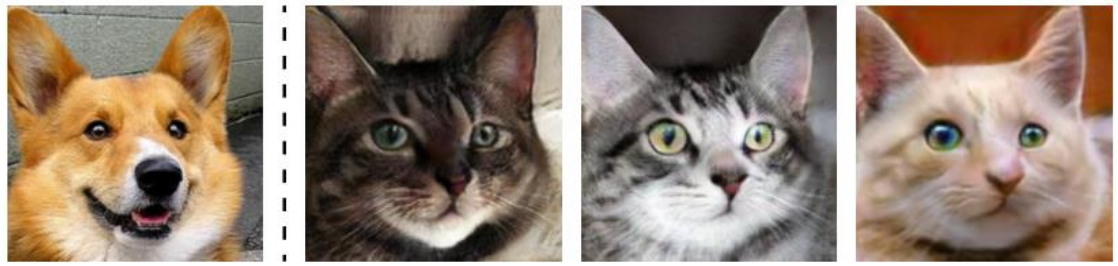
- Relaxes Cyclic constraint, by having a style and content feature



(a) Within-domain reconstruction

(b) Cross-domain translation

(c) house cats → dogs



(d) dogs → house cats

Practicalities

- Deadline for assignment: Wednesday 26th of June 23:59.
- Exam: Thursday and Friday
  - Updated document with examination times on DTU Inside