# CycleGAN walktrough

Summer School on Generative Models

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#### Overview

- Brief introduction to domain transfer/pix2pix
- CycleGAN
  - Concept
  - Architecture
  - Training



- 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

PixelGAN

PatchGAN

ImageGAN



# Pix2pix

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



#### What if we don't have paired training examples?







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



#### CycleGAN Domain Transfer Examples



Photograph

Monet

Van Gogh

Cezanne

Ukiyo-e

#### CycleGAN losses overview

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

Fool discriminator Cycle Consistency Identity loss



CycleGAN architecture

Generator



Architecture and values from official implementation on github

CycleGAN architecture

• Discriminator



Architecture and values from official implementation on github

PatchGAN!

# 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

# Sample results (30 epochs training)

Original

Fake

Recovered

Identity



Horse2Zebra

Zebra2Horse

#### CycleGAN – Failure case

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



# GAN training trick

- Discriminator should be able to classify all generated images as fake
  - Not just the ones currently generated by G
- Idea:
  - Keep a buffer of generated images and update the discriminator using image sampled from buffer

# Training GANs is hard!



Experiments Result they show in papers

Experiments Result you try to reproduce

# 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





 $x_1$ 

 $x_2$ 

(a) Within-domain reconstruction



(c) house cats  $\rightarrow$  dogs

M. Eltrando -

(d) dogs  $\rightarrow$  house cats

(b) Cross-domain translation

# Thank you for listening

- CycleGAN is a tried and true method for doing style transfer
- Now:
  - Continue doing the exercise