

# The Effectiveness of Data Augmentation in Image Classification using Deep Learning

Rusnak A.D.

Department of Mechanics and Mathematics

March 9, 2021

# Basic approaches

- Traditional Transformations
- Generative Adversarial Networks
- Learning the Augmentation

# Traditional Transformations

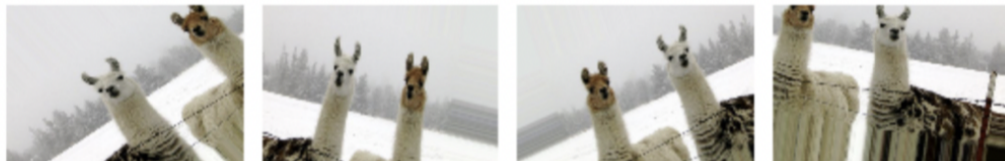


Figure I: Traditional Transformations

# Generative Adversarial Networks



Figure II: Style Transformations via GANs

# Learning the Augmentation

- Content loss

$$L_a^{content} = \frac{1}{D^2} \sum_{ij} (A_{ij} - T_{ij})$$

- Style loss via gram matrix

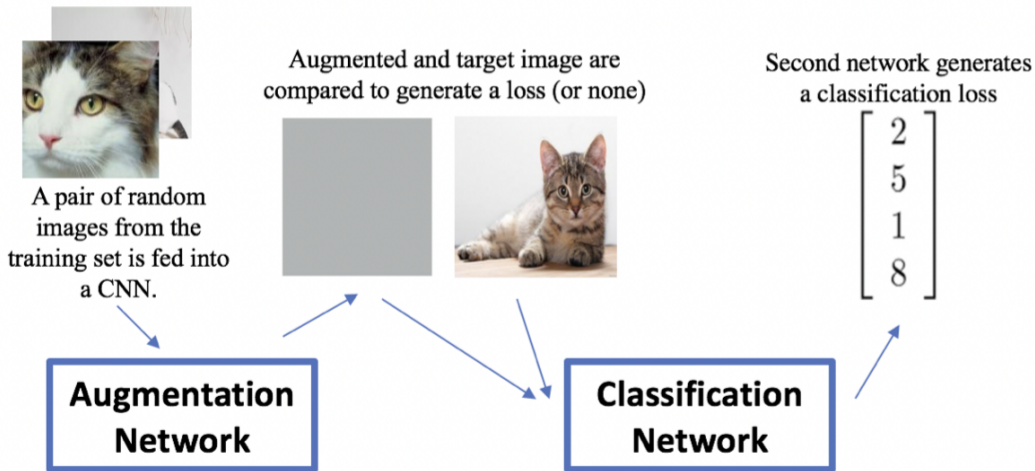
$$G_{ij} = \sum_k F_{ik} F_{jk}$$

$$L_a^{style} = \frac{1}{C^2} \sum_{ij} (G_{ij}^A - G_{ij}^T)$$

$$\alpha L_c + \beta L_a$$

- No loss is computed at this layer

# Architecture



# Classification network: SmallNet

- Conv with 16 channels and 3x3 filters. Relu activations.
- Batch normalization.
- Max pooling with 2x2 filters and 2x2 stride.
- Conv with 32 channels and 3x3 filters. Relu activations.
- Conv with 32 channels and 3x3 filters. Relu activations.
- Batch normalization.
- Max pooling with 2x2 filters and 2x2 stride.
- Fully connected with output dimension 1024. Dropout.
- Fully connected layer with output dimension 2.

# Augmentation Network

- Conv with 16 channels and 3x3 filters. Relu activations.
- Conv with 16 channels and 3x3 filters. Relu activations.
- Conv with 16 channels and 3x3 filters. Relu activations.
- Conv with 16 channels and 3x3 filters. Relu activations.
- Conv with 3 channels and 3x3 filters.



# Datasets and Features

- Tiny-ImageNet-200 (500 images from dogs and 500 images from cats) 64x64x3
- MNIST, 1000 images from each class 28x28x1

# Results

Dogs vs Goldfish	
Augmentation	Val. Acc.
None	0.855
Traditional	0.890
GANs	0.865
Neural + No Loss	<b>0.915</b>
Neural + Content Loss	<u>0.900</u>
Neural + Style	<u>0.890</u>
Control	0.840

Table I: Quantitative Results on Dogs vs Goldfish

Dogs vs Cat	
Augmentation	Val. Acc.
None	0.705
Traditional	<b>0.775</b>
GANs	0.720
Neural + No Loss	<u>0.765</u>
Neural + Content Loss	<u>0.770</u>
Neural + Style	<u>0.740</u>
Control	0.710

Table II: Quantitative Results on Dogs vs Cats

MNIST 0's and 8's	
Augmentation	Val. Acc.
None	0.972
Neural + No Loss	<b>0.975</b>
Neural + Content Loss	<u>0.968</u>

Table III: MNIST

# Examples



Figure V: Goldfish sample I



Figure VI: Goldfish sample II

# Examples



Figure VII: Dog sample I



Figure X: Dog sample IV

# Examples



Figure VIII: Dog sample II



Figure IX: Dog sample III