Target-Aware Generative Augmentations for Single-Shot Adaptation

Kowshik Thopalli*, Rakshith Subramanyam*, Pavan Turaga, Jayaraman J. Thiagarajan

How can I improve the performance of classifiers under real-world distribution shifts?

Adapt the model with target domain data!
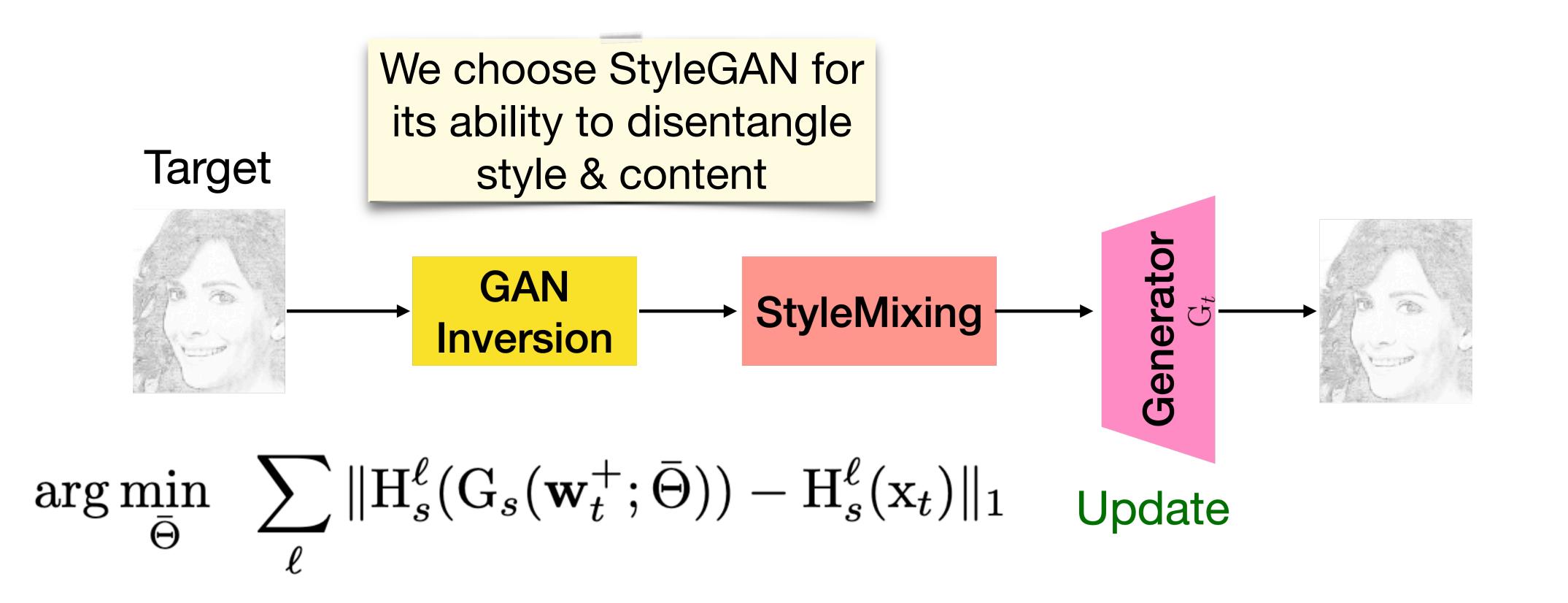Sure! But I am severely constrained for data ☹

Synthetic data augmentations could help!
I tried using toolbox augmentations. No luck ☹

I hear generative models are great. Try them?
Cool. I will check if they are useful in augmenting data-constrained target domains 😃

Step 1: Transfer source generator with 1-shot target

We choose StyleGAN for its ability to disentangle style & content

Target → GAN Inversion → StyleMixing → Generator G_i → Update

$$\arg\min_{\bar{\Theta}} \sum_{\ell} \|H_s^\ell(G_s(w_t^+; \bar{\Theta})) - H_s^\ell(x_t)\|_1$$

Step 2: Generate synthetic "target" samples

Activation Maps of Conv Layer

Generator

Prune-Zero: Zero-out low activation values to attenuate some target-specific style attributes

Prune-Rewind: Rewind low activation values to source and enable smooth domain transition

Step 3: Adapt solely on synthesized data

Face Attribute Detection under Shifts

CelebA Dataset   StyleGAN-V2

	water color		color sketch		pencil sketch	
Target Domain						
No Adaptation	74.1		63.4		53.2	
MEMO	72.8		59.1		55.7	
SiSTA (Base)	80.2	+12.5	74.2	+17.8	71.2	+30.0
SiSTA (PZ)	83.0		73.1		75.6	
SiSTA (PR)	86.6		81.2		83.2	
Full Target DA	87.5		78.1		84.6	

As the distribution shift severity grows, the benefits of SiSTA become more apparent!

Impact of Synthetic Dataset Size

Smiling — Mouth Open — Arched Eyebrows

SiSTA (prune zero)   SiSTA (prune rewind)

SiSTA (PR) typically requires larger synthetic data sizes than SiSTA (PZ) for stable convergence

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A Practical Implementation of SiSTA

→ submit single target sample
→ return source classifier
→ return target domain augmentations

data, classifier, generator → vendor → client → collect target domain data

1. Perform GAN adaptation
2. Generate synthetic augmentation

Perform SFDA with synthetic target data

Extending SiSTA to Multi-Class Problems

Multiple class-specific StyleGANs

AFHQ   StyleGAN-ADA

Target Domain 1-shot Data

SiSTA-G   SiSTA-G

CAT Generator   DOG Generator   WILDLIFE Generator

Method	Accuracy
MEMO	80.1
SiSTA	97.7
Full Target DA	97.2

Single class-conditioned StyleGANs

CIFAR-10

Target Domain 1-shot Data

Sample from only one class

SiSTA-mcG

CIFAR-10 Generator

Matches Full Target DA

SiSTA (10 classes) ⭐ 52.3
SiSTA (5 classes) 50.1
SiSTA (1 class) 49.7
No Adaptation 37.9

Can SiSTA Handle Image Corruptions?

CelebA Dataset   StyleGAN-V2

MEMO   SiSTA

Corruption	MEMO	SiSTA
Fog	62.2	70.2
Snow	58.2	72.8
Contrast	53.3	64.1
Frost	58	64.8

Accuracy (%)

Even on standard image corruptions, SiSTA outperforms toolbox augmentations!

Utility of SiSTA with Large-Scale StyleGANs

DomainNet   StyleGAN-XL

MEMO   SiSTA   Full Target DA

Sketch: 55.1, 48.1, 43.8
Infograph: 31.8, 31.8, 28.6
Painting: 68.9, 64.1, 62.2

SiSTA (Base)   SiSTA (Prune Rewind)   SiSTA (Prune Zero)