Hochschule der Medien
Fakultät für Druck und Medien
Computer Science and Media

Generative Data Augmentation

Multi-Agent Diverse Generative Adversarial Networks for Generative Data Augmentation

Dissertation submitted for the degree of Master of Science

Topic: Generative Data Aufmentation

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Version of Date: March 22, 2025

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Abstract

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Contents

List of Figures

List of Tables

List of Abbrevations

CNN ..... Convolutional Neural Network
CNNs ..... Convolutional Neural Networks
DNN ..... Deep Neural Network
FFN ..... Feed Forward Netzwerk
GAN ..... Generative Adversarial Network
GANs ..... Generative Adversarial Networks
GANsa ..... Generative Adversarial Networksaaaaaaaaaaaaaaa
GDA ..... Generative Data Augmentation
MLP ..... Multi Layer Perceptron
NN ..... Neural Netzwerk
SLP ..... Single Layer Perceptron

1 Introduction and Motivation

Generative Adverserial Netwrorks (GANs) [GPAM+14] and their variants revolutionized the field of computer vision in the year of 2014, enabling advacements in multiple areas of generating data. From *Text to Image Synthesis* [RAY+16], *Image Translation* [IZZE18], *Super Resolution* [LTH+17], *Image Inpainting* [PKD+16], *Style Transfer* [WWR+23] to *Data Augmentation* [SK19], GANs have been used in a variety of applications.

The idea of using GANs for Generative Data Augmentation (GDA) has already been applied sucessfully, e.g.: in computer vision [JLR25], [BNI+23] or for creating music [JLY20]. Especially the former survey *A Comprehensive Survey of Image Generation Models Based on Deep Learning* has, along Variational Auto Encoders (VAEs), a dedicated focus on GANs. Despite of the mentioned achievements, in praxis GANs suffer from multiple problems, complicating the training and inference process:

- Mode Collapse
- Loss of inter-class Diversity
- Failure to Converge
- Vanishing Gradiants
- Unstable Gradiants
- Imbalance between Generator- and Discriminator Model

This thesis investigates the potential of using GANs - specifically *Multi-Agent Diverse Generative Adversarial Networks* (MADGANs) [GKN+18] - for Generative Data Augmentation. MADGANs aim to aid the first two of the afore mentioned in particular: Mode Collapse and Loss of inter-class Diversity. They, along other modifications, "*propose to modify the objective function of the discriminator, in which, along with finding the real and the fake samples, the discriminator also has to correctly predict the generator that generated the given fake sample.*" [GKN+18]. The goal of this adjustment of the discriminator is, that the discriminator has to push the generators towards distinct identifiable modes. In their paper, they experimentally show, that their architectural adjustment of GANs is generally capable of giving providing assistance for first two of the mentioned problems.

The experiments in this work are structured in to three major parts. The first set trains and analyses GANs, explicitly MADGANs and Conditional GANs (CGANs). Here, the quality of the resulting images during training will be judged by the Fréchet Inception Distance (FID) [HRU+18] and the Inception Score (IS) [SGZ+16]. The secoond set uses the afore trained generative models to create images. Images without labels - images originating from MADGANs - will be classified using auxilary classifiers trained using classical data augmentation techniques. The third and most significant set of experiments traines classifiers, using the generated data. For this, stratified

classifiers, with differing numbers of real and fake images are trained and evaluated on the respective validation set and their classification performance will be judged by standard metrics.

All of the above described is executed on the following datasets:

- MNIST [LCB10]
- Fashion MNIST [XRV17]
- CIFAR10 [Kri09]

Aim of the Thesis The aim of the thesis is to investigate the potential use of MADGANs for GDA and compare their performance against traditional data augmentation techniques. Traditional techniques involve altering operation on the training images, such as flipping, rotating, cropping images, altering their contrasts and adding a small amount of noise to them.

2 Related Work

3 Preliminary Remarks

4 Theoretical Background

5 Theoretical Background

6 Experiments Results

Motivation

7 Outlook

repair networks [TFNL22]

8 Conclusion

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Appendix

Declaration of Academic Integrity

Generative Data Augmentation

Multi-Agent Diverse Generative Adversarial Networks for Generative Data Augmentation.

I hereby declare that I have written this thesis independently. I have properly cited all passages that are taken verbatim or in essence from published or unpublished works of others. All sources and aids used in the preparation of this thesis have been fully acknowledged. Furthermore, this thesis has not been submitted, in whole or in substantial part, to any other examination authority for academic credit.

Signiture : *Place*, *Date* :