# Implementation and Comparison of DCGAN, WGAN, and ACGAN on CIFAR-10 Dataset
GitHub Repository

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## 1 Introduction

This project implements and compares three different Generative Adversarial Network (GAN) architectures: DCGAN, WGAN, and ACGAN, trained on the CIFAR-10 dataset. The implementations explore various GAN training techniques and architectural improvements to generate high-quality images.

## 2 Methodology

### 2.1 Dataset

The CIFAR-10 dataset was used for training, consisting of 60,000 32x32 color images across 10 classes. Images were preprocessed to 64x64 resolution and normalized to [-1, 1] range.

### 2.2 Model Architectures

#### 2.2.1 DCGAN

The DCGAN implementation features:

- Generator: Transposed convolutions with batch normalization and ReLU
- Discriminator: Convolutional layers with LeakyReLU
- Adam optimizer with learning rate 5e-5 and beta1 = 0.5

#### 2.2.2 WGAN

Key improvements in the WGAN implementation include:

- Wasserstein distance as loss function
- Gradient penalty for improved stability
- RMSprop optimizer
- Multiple critic updates per generator update (5 critic iterations)

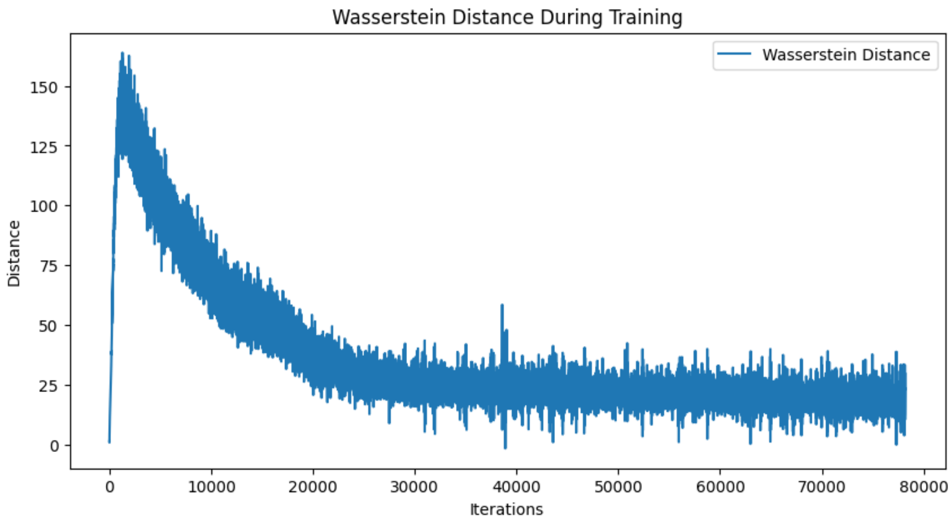


Figure 1: Wasserstein Distance During Training - showing the convergence of the WGAN model

#### 2.2.3 ACGAN

The ACGAN architecture incorporates:

- Auxiliary classifier in the discriminator
- Class-conditional generation
- Combined adversarial and classification loss

## 3 Training and Results

### 3.1 Training Dynamics

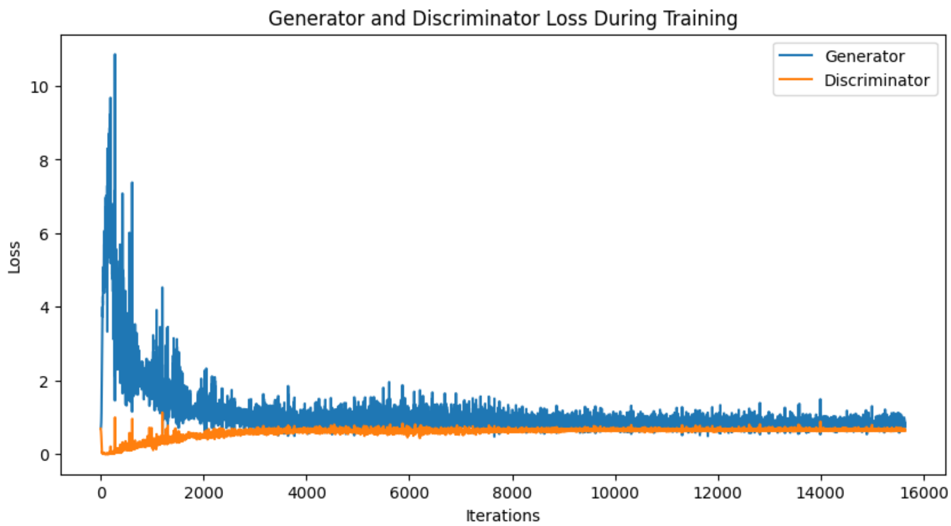


Figure 2: Generator and Discriminator Loss During Training for DCGAN

### 3.2 Image Generation Quality

Each model's ability to generate realistic images was evaluated through both quantitative metrics and visual inspection.

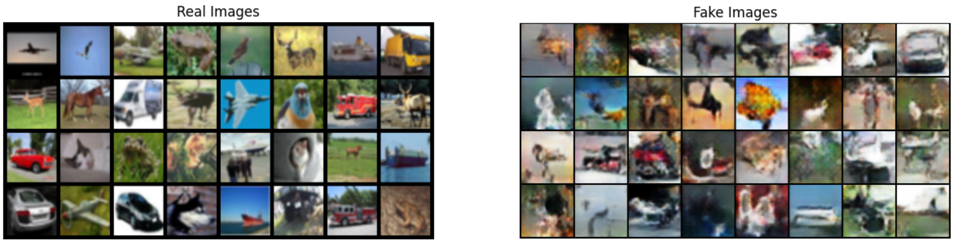


Figure 3: Comparison of Real vs Generated Images from DCGAN

### 3.3 FID Score Analysis

The Fréchet Inception Distance (FID) was used to quantitatively evaluate the quality of generated images. Lower FID scores indicate better quality and diversity in generated samples.

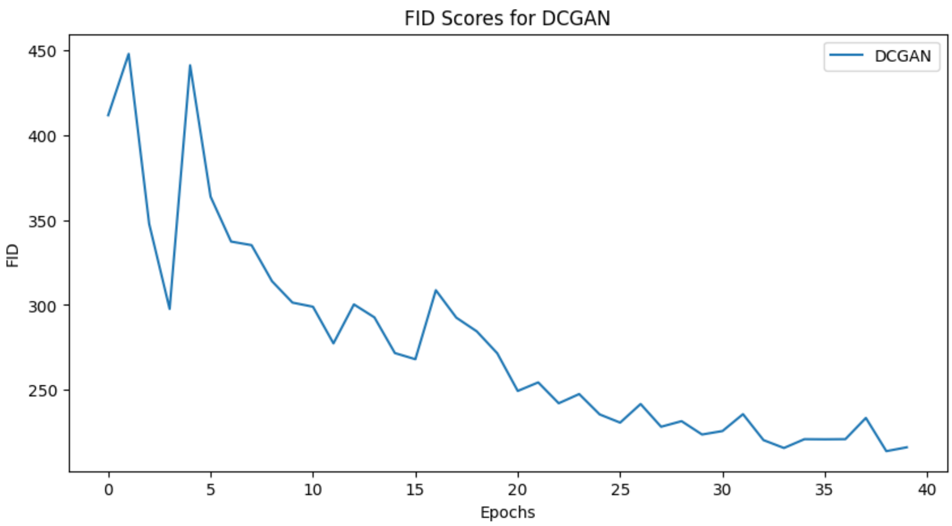


Figure 4: FID Scores Throughout Training

## 4 Discussion

The implementations revealed several key insights:

- WGAN showed improved training stability as evidenced by the Wasserstein distance plot
- The FID scores demonstrate the relative performance of each model in terms of image quality
- Loss curves indicate that the models successfully achieved convergence during training

## 5 Conclusion

Each GAN variant showed distinct advantages:

- DCGAN provided a solid baseline with stable training dynamics
- WGAN demonstrated improved stability through Wasserstein distance optimization
- ACGAN offered enhanced control over generated content through conditional generation

These results demonstrate the evolution of GAN architectures and their respective strengths in image generation tasks. The visual and quantitative metrics suggest that while all models successfully learned to generate images, each architecture offers unique benefits for different aspects of the generation task.