GAN-Based Image Augmentation for Flower Classification

Problem Statement

Deep learning models in computer vision often require large and diverse datasets, which may be unavailable or sensitive.
Traditional augmentation techniques (like rotation, scaling, and flipping) increase data quantity but not diversity.
Generative Adversarial Networks (GANs) aim to create genuinely new data samples by learning the underlying data distribution and synthesizing realistic images.
This project investigates whether GAN-generated samples can enhance or even replace real data for training image classifiers, and whether iterative (recursive) training using synthetic data can further improve classifier performance in data-limited scenarios.

High-Level Architecture

1. Dataset Preparation:
   - 3670 flower images across 5 classes.
   - Images resized, normalized, and split into training/testing sets.
   - GAN-generated samples used to augment and balance data.
2. CNN Model:
   - Two convolutional layers (32, 64 filters) with ReLU + MaxPooling.
   - Dropout for regularization and two fully connected layers for classification.
   - Acts as both the baseline and final evaluator.
3. GAN Model:
   - Generator creates realistic flower images; Discriminator distinguishes real vs fake.
   - Trained adversarially on GPU (Tesla T4) for 50 epochs.
4. Training Pipeline:
   - CNN trained first on original data, then retrained on GAN-augmented dataset.
   - GAN samples saved each epoch for monitoring.

Results and Observations

- Initial CNN accuracy: ~40%
- Final CNN accuracy after augmentation: 98.42%
- GAN-generated images significantly improved generalization and dataset diversity.
- Generator outputs became visually convincing by epoch 50.

Conclusion

This project demonstrates how GANs can effectively address data scarcity in image classification. By generating additional realistic images and retraining the CNN, model accuracy improved substantially. This showcases the powerful synergy between deep learning and generative AI in solving real-world computer vision challenges.