Scenario 1 : Task with generating realistic human face images using a Generative Adversarial Network (GAN)

Scenario Based Questions:

You are tasked with generating realistic human face images using a Generative Adversarial Network (GAN). The dataset contains thousands of real human face images.

a) Explain how GANs work in this context, clearly identifying the roles of the Generator and the Discriminator.
b) Describe the adversarial training process and how it leads to the generation of realistic images over time.
c) List at least two real-world applications of such GAN-generated face images and discuss one ethical concern related to this technology.

Solution

a) Explanation of GANs in this context

Generative Adversarial Networks (GANs) consist of two neural networks: a **Generator (G)** and a **Discriminator (D)**.

- In this scenario, the **Generator** takes random noise as input and tries to create realistic-looking human face images.
- The **Discriminator** takes both real images (from the dataset) and fake images (from the Generator) and attempts to distinguish between them.

The Generator's goal is to produce images so realistic that the Discriminator cannot tell they are fake. Conversely, the Discriminator's goal is to correctly identify which images are real and which are generated.

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b) Adversarial Training Process

The training of a GAN is a **minimax game** between the Generator and the Discriminator:

- Initially, the Generator produces poor-quality images, as it starts with random noise.

- The Discriminator easily detects these as fake.
- The Generator uses the Discriminator's feedback to improve its image generation, updating its parameters via backpropagation.
- Simultaneously, the Discriminator is trained with both real and fake images to improve its ability to classify them accurately.

Over time:

- The Generator gets better at creating realistic faces.
- The Discriminator becomes more robust at spotting fakes, forcing the Generator to improve further.
- Training continues until the Discriminator can no longer reliably distinguish real from fake — indicating that the Generator has learned to produce **photo-realistic human faces**.

c) Real-World Applications and Ethical Concern (3 marks):

Applications:

1. **Synthetic dataset creation** for training face detection or recognition models without using real identities.
2. **Game development and virtual avatars**, where realistic faces are needed for non-player characters (NPCs) or customizable user profiles.

Ethical Concern:

- **Deepfake misuse**: GAN-generated faces can be used to create fake identities or impersonations, leading to misinformation, identity theft, or privacy violations.

Scenario 2: Predicting Stock Prices Using RNN

Context:
A financial analyst at a stock trading company wants to predict the future closing prices of a company's stock based on past performance. She decides to use a machine learning model that can understand sequences and trends over time.

Problem:
Stock prices are time-series data, where today's price depends on previous days' prices. Traditional models struggle with such sequential data. The analyst needs a model that can remember past prices and use them to forecast the next.

Solution:
She uses a **Recurrent Neural Network (RNN)** because it's designed to process sequential data. The RNN takes in stock prices from the past 30 days and learns the pattern in these sequences. Then it predicts the stock price for the next day.

Workflow:

1. Collect daily closing prices for the last 5 years.
2. Normalize the data.
3. Feed sequences of 30 days of prices to the RNN.
4. The RNN processes the sequence step-by-step, remembering previous values using hidden states.
5. After training, the RNN predicts the next day's price based on the last 30 days of prices.