

# Face Modification using VAE, $\beta$ -VAE, VQ-VAE and GAN

## Assignment Overview

In this assignment, you will implement and compare four generative modeling approaches for face modification and synthesis:

1. **Variational Autoencoder (VAE)**
2.  **$\beta$ -Variational Autoencoder ( $\beta$ -VAE)**
3. **Vector Quantized VAE (VQ-VAE)** with **PixelCNN** prior for latent sampling
4. **Generative Adversarial Network (GAN)**

The goal is to understand how different latent representations influence **reconstruction quality**, **attribute manipulation**, and **sample realism** in face images. Use provisioned WILP lab infrastructure!

## Dataset

Use **CelebA** dataset.

## Preprocessing

- Resize images to **64×64** or **128×128**
- Normalize pixel values to  $[0,1]$
- Optionally select attributes (e.g., Smiling, Male, Eyeglasses)

## Part A: Variational Autoencoder (VAE) [2 Marks]

### Tasks

1. Train the VAE
2. Visualize reconstructions
3. Perform **latent interpolation** between two faces
4. Perform **attribute modification** by vector arithmetic

## Part B: $\beta$ -VAE [2 Marks]

Use  $\beta \in \{2, 4, 10\}$

### Tasks

1. Train models with different  $\beta$  values
2. Perform **latent traversal** (vary one dimension at a time)
3. Identify dimensions controlling attributes (smile, gender, pose)
4. Compare reconstruction vs disentanglement trade-off

## Part C: VQ-VAE with PixelCNN Prior [3 Marks]

Use Codebook size  $K$  (e.g., 512)

### **Tasks**

1. Train VQ-VAE and report reconstruction quality
2. Extract discrete latent maps
3. Train PixelCNN over latents
4. Sample new latent codes using PixelCNN
5. Generate faces from sampled latents

### **Part D: GAN for Face Generation [2 Marks]**

#### **Tasks**

1. Train GAN on face dataset
2. Generate random face samples
3. Perform latent interpolation
4. Compare realism vs VAE-based models

### **Part E: Comparative Analysis [1 Mark]**

Include visual examples.

#### **Deliverables**

1. **ipynb** notebook (PyTorch / TensorFlow) with
  - Training curves
  - Visual results
  - Comparative discussion (reconstruction error, sampling quality, latent control, speed)
2. Corresponding **PDF** file