Ayna ML Assignment

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Report

Introduction

This project was an interesting hands-on exercise in building a small but effective UNet architecture for image generation. It helped brush up various concepts in convolutional neural networks, encoder-decoder architectures, and conditioning mechanisms. This report outlines the initial design choices, the challenges encountered, the solutions implemented, and best practices for future model tuning.

Initial Architecture Choice

The suggested resource to be used i.e building upon a pre-existing architecture (UNet2DConditionModel) was first leveraged against a simple architecture tuned to this use case. After careful consideration, I decided to go ahead with building a custom model to avoid the complexity of the diffusion model as the task at hand is only simple color embedding, one which does not require the overhead of adapting a large general-purpose architecture.

Base Architecture Design

* Input: The model accepts a single-channel grayscale image and a color index.
* Color Embedding: The color index is processed by an nn.Embedding layer, which generates a color embedding vector.
* Contracting Path: The grayscale image first passes through a DoubleConv layer, followed sequentially by down1, down2, and down3 blocks.
* Bottleneck: The output of down3 is then processed by the down4 block. At this point, the color embedding is concatenated with the output of down4.
* Expansive Path: The conditioned feature map is upsampled and passed through the up1 block, which receives a skip connection from down3. This process continues sequentially with up2 (with a skip from down2), up3 (with a skip from down1), and up4 (with a skip from the DoubleConv layer).
* Output: Finally, the output of up4 is passed through the OutConv layer, which generates the final 3-channel RGB image.

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References

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Last Name, C. D. (Year). *Book Title (Edition).* Publisher Name. URL.

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