Deep Learning

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Image Completion with DCGAN

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Introduction

The aim of this project is to create a deep learning model that, given an image that has a missing part, completes it by filling in the missing pixels in a way that looks natural to the human eye. This goal is achieved by constructing and training a Deep Convolutional Neural Network (DCGAN) that learns the distribution of a given data set of images and produces new random samples from that distribution. Then, the generative model is optimized to produce an image that most resembles the image we want to complete. The generated image is then used to patch the incomplete image.

Architecture

The DCGAN is composed of two submodels:
a generator and a discriminator.
The discriminator is a CNN classifier that receives an image as an input and outputs the probability of that image being real.
The generator receives an random input vector (Z) from a normal distribution and, using transpose convolution layers, upsamples the input and outputs an image.

Training

During training, the discriminator (D) learns to distinguish between the fake images that the generator (G) produces and the real images from the data. The generator learns to produce fake images that 'fool' the discriminator (that is, images that look real). This is achieved by optimizing following loss function :

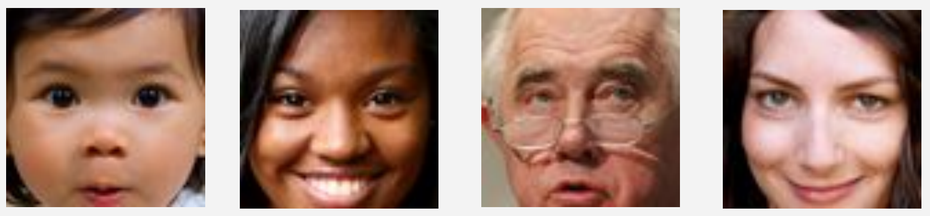
$$\min_G \max_D \mathbb{E}_{x\sim p_{\text{data}}} \log D(x) + \mathbb{E}_{z\sim p_z}[\log(1 - D(G(z)))]$$

Image completion

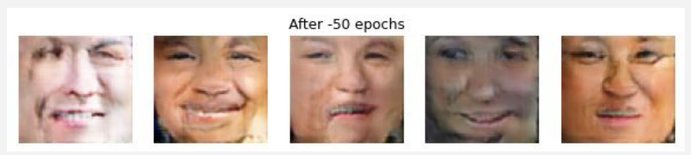
Having now a trained generator that produces a natural looking image, given an input vector Z, we can optimize it with respect to Z in order to generate an image that resembles the one we wish to complete. We can now use the generated image to patch the incomplete one.

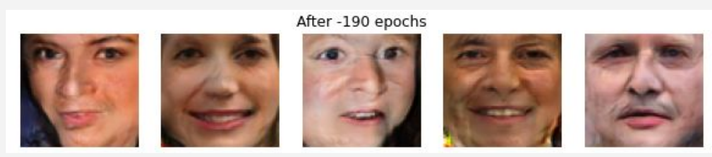
The Data

This project uses the FFHQ faces dataset.
The images have been cropped to a size of 64x64x3 and the model was trained on a total of 30,000 images.

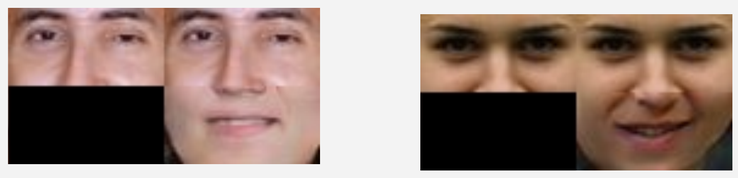


The Generator during training





Final Results - Image Completion



In Conclusion - Generative Adversarial Networks are a powerful tool that is able to learn an approximation of a distribution of given data samples. This project aims to show this in a clear, visual way, using images of faces as an example, learning their distribution and generating new images in order to patch incomplete images.