MAIS202 Deliverable 1

Group 1

Project Proposal

Our project will be developing a machine learning model that can colourize black and white photos.

Choice of Dataset

1) https://www.kaggle.com/datasets/bigquery/open-images?select=images
    a. Will require conversion from RBG to Lab and image resizing
2) https://www.kaggle.com/datasets/shravankumar9892/image-colorization
    a. Images already in Lab

Methodology

From this dataset, we want to be able to accurately colourize greyscale images. Images are typically represented using three colour channels, red, green, and blue (RGB). Within each layer are grids of pixels, each storing a value that spans a particular range to define brightness. Using the models described below, we can create a relationship between the input greyscale channel to the three output color channels.

A) Data Pre-Processing

The RBG colour space does not contain information on illumination [1] and requires three output layers. In contrast, the images can be transformed into either the YCbCr or Lab colour spaces, which reduces the complexity by enabling the model to predict only two channels [2].

$$Net(L) = [R, G, B] => Net(L) = [a, b]\ (Lab\ colour\ space)$$

Prior to transforming the images into a new colour space, the pixel values will be normalized by the maximum value an RGB pixel can reach (255). Finally, the images are resized to have the same dimensions [3].

B) Proposed Machine Learning Model

Convolutional neural networks (CNNs) are deep learning algorithms that can take in images as input. The model consists of convolution operations that extract the features of an image. With more operations (layers), more features can be extracted [4]. These operations can either increase, reduce, or keep the dimensionality the same, creating a link between the single input layer to the three output layers.

Autoencoders are a type of CNN architecture. They are composed of encoders and decoders, which are responsible for the extraction of relevant features (encoders) and the recovery of the input image (decoder) [5].

Evaluation Metric

The black-and-white photo colourizer model can be evaluated in a lot of ways. We can evaluate the precision of our model by calculating classification accuracy for the model, which is just the ratio of the number of correct predictions to the total number of input samples. In our case, this could be done using a test set of colourised photos, decolourising them and colourising them using the machine learning models. Then, a group of pixels can be randomly selected and the only the dominant RGB values of the same set of pixels are then compared between the original pictures and the pictures produced from the model since

not all three RGB values are significant for each pixel. If the values for the produced pixels are within a certain deviation from the original pixels, it can be classified as a correct prediction.

We can also apply the root-mean-squared-error (RMSE) test to calculate on average, how much our dominant RGB values deviate from the original. The RMSE Metric is given by:

$$RMSE = \sqrt{\frac{\sum_{i=1}^{N} (Predicted_i - Actual_i)^2}{N}}$$

where N is the number of observations.

The RMSE metric can also be used as an indicator to improve our model through constant testing. A lower value indicates a more accurate model.

Application

The user will upload a black and white photo that they want to see colourized. This can be done through some sort of submission box, where they can choose to upload photos from their device. The user will receive the colourized photo as output. For stylistic purposes, the uploaded photo and colourized photo will be displayed side by side. The user can choose whether to save the colourized photo.

Works Cited

[1] Tripathi, S. (2021, December 13). Coloring Black & White Images Using Deep Learning - DataDrivenInvestor. Medium. Retrieved October 9, 2022, from https://medium.datadriveninvestor.com/coloring-black-white-images-using-deep-learning-984e6f4ddf14

[2] Guilbert, A. (2022, January 6). Black and White Image Colorization with Deep Learning. Medium. Retrieved October 9, 2022, from https://anne-guilbert.medium.com/black-and-white-image-colorization-with-deep-learning-53855922cda6

[3] El-Jiddawi, M. (2021, December 10). Auto Colorization of Black and White Images using Machine Learning "Auto-encoders" technique. Medium. Retrieved October 9, 2022, from https://becominghuman.ai/auto-colorization-of-black-and-white-images-using-machine-learning-auto-encoders-technique-a213b47f7339

[4] Saha, S. (2021, December 7). A Comprehensive Guide to Convolutional Neural Networks — the ELI5 way. Medium. Retrieved October 9, 2022, from https://towardsdatascience.com/a-comprehensive-guide-to-convolutional-neural-networks-the-eli5-way-3bd2b1164a53

[5] Lewinson, E. (2021, December 14). Image Colorization using Convolutional Autoencoders. Medium. Retrieved October 9, 2022, from https://towardsdatascience.com/image-colorization-using-convolutional-autoencoders-fdabc1cb1dbe