Deep Learning Exam - Image De-blurring

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June 2022

Introduction

The task consists in creating a de-blurring deep learning model, aimed to remove gaussian blur and gaussian noise from images. The goal is to create a model which, taken a blurred image X, is able to reconstruct the original de-blurred image y.

1 The dataset

The dataset is built starting from CIFAR-10 images collection, a Gaussian Blur filter is applied to obtain the blurred images used to train the models. Then, it is split into training set and test set.

2 Model 1

In this first approach we will try to exploit CNN's by means of an Auto-Encoder structure to check if we can solve the problem of de-blurring images. The theory behind that is focused on taking an input image and storing the details of that image into a different format whose size is smaller than the size of the image.
These stored details can then later be used to try to recreate either the same image or a different image based upon the input image (i.e. the original one).
The structure of the model is the following:

- Encoder: consists only in a series of Convolutional Layers of a different number of filters to extract features from the (blurred) input image to transfer onto a hidden layer.
- Decoder: starting from the feature map of the hidden layer, it deconvolves to get back a de-blurred image by means of Convolution Transpose Layers.

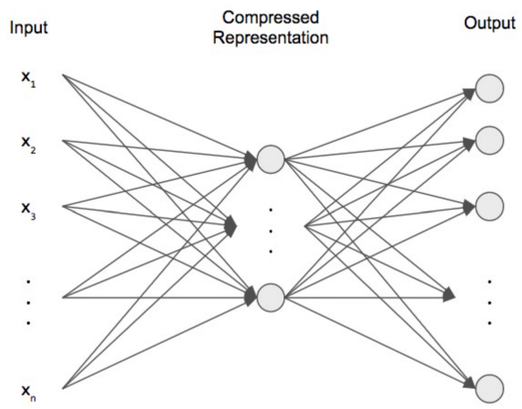

Figure 1: Auto Encoder

3 Model 2

In this second section, we try to build a different model with a functional approach: we try to use residual blocks to see if it is possible to obtain different (and possibly better) results in the reconstruction of the original image.

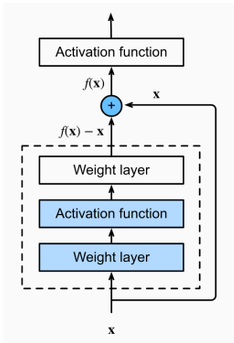

Figure 2: Residual Block

By means of using the modular function provided, the model can be built specifying different parameters to test several distinct version of the same, the best configuration is the following:

- height of the image = 32
- width of the image = 32
- num_channels for the convolutional layers = 64
- num_res_blocks of the network = 5

4 Performance evaluation and results

Both the models have been compiled using Mean Squared Error (mse) and Adam as optimizer, and also using a validation split of 20%.
It is possible to try different combinations of parameters to improve the training process in terms of quality of the results, but also computational time spent, but these were the ones that produced better results:

- epochs = 20
- batch size = 32
- learning rate = 0.001

Both the models have been tested with data from the test set to check if they are sufficiently capable to generalize and so to perform a good de-blurring operation to solve the task. These are the results obtained for the given metric (mse):

- Model 1 = 0.0026
- Model 2 = 0.0023

5 Conclusions

In order to synthesize the comparison of the quality of the results, let's make a direct comparison between the reconstructed images obtained by the 2 models presented before.

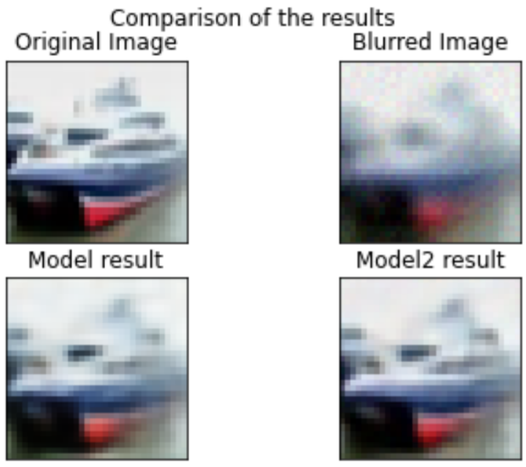

Figure 3: Comparison between results

It can be noticed, by simply looking at the figure shown above, that both the models are able to improve the general "quality" of the image performing a de-blurring operation. Visually Model 2 seems to produce slightly better results in some cases, but results are similar.