**Pipeline Evaluations**

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The evaluation of machine learning (ML) pipelines is essential during the process of creating and optimising pipelines. The time taken to compose and optimise the pipeline takes time, but the outcome will bring the chosen machine learning model to output better, more accurate predictions. In this document, evaluations will take place on our pre-processing techniques, and which ones are best fit for our image recognition system.

The process of creating a pipeline comes in the form of cleaning the data, and for image classification or recognition systems, there are four main types.

This document will go over pre-processing techniques and their implementation in our Mushroom Classification System.

The first is Pixel Brightness Correction, which comes in the form of correcting the brightness of the image, correcting the gamma of the image and gray scale transformation [1]. Correcting the brightness of an image modifies each pixels brightness, and the output pixel’s value only depending on the corresponding input pixel value. Gamma correction is a non-linear adjustment to individual pixel values and causes the saturation of the image being altered. For example, if the majority of mushroom images are taken mid-day in bright light, it might be easier for the model to recognise them, however, there may be some which were taken at night, in which it is harder for the model to identify the image. Brightness and gamma correction can brighten up the image and make the image which needs to be identified stand out more, causing the model to be able to pick it up with more accuracy.

The next technique is Histogram Equalization. This is a contrast enhancement technique which has shown success on all types of images[2]. This technique is more sophisticated than other methods since it modifies the dynamic range and contrast of an image by altering it such that its intensity histogram has the desired shape. It can employ either linear or non-linear functions to map between pixel intensity values in the input and output images. A drawback of this technique is that it can change the brightness of an image significantly, which is not desired and can therefore make it so the image is unusable and cannot be trained into the model[5].

Another technique is Sigmoid Stretching, which is a nonlinear continuous function, which adjusts the contrast and threshold value of the image to make it possible to tailor the amount of lightening and darkening of the image to control the overall contrast enhancement [3]. For example, if an image of a mushroom had been taking with a bright light shining over it, the image could come out extremely light, almost looking as if a white filter had been placed over it. Using sigmoid stretching, the lightening of the image could be decreased, and the darkening could be increased to level out the amount of light and contrast in the image. Using this technique, it has shown to provide great results, with images that have had Sigmoid Stretching performed on them, reaching greater accuracies in models compared to other methods, this is shown in Al-Ameen’s study, where this technique outperformed other comparative techniques in terms of accuracy and perceived quality of the image [7].

The final technique is Geometric Transformation [4]. Whereas the above techniques discuss techniques that regard colour, brightness, and contrast, this technique focuses on the position of pixels in an image and modifying those, whereas the colour and saturation of the image remain unchanged. The operations this technique uses are the rotation, scaling and distortion of images. Spatial transformation of the physical rearrangement of the pixels in the image are carried out first, then grey level interpolation is carried out, which assigns grey levels to the newly transformed image. There are different interpolation methods for this technique, such as the Nearest Neighbour interpolation that re samples the pixel values present in the input vector, and the Linear interpolation method explores four points neighbouring the point, and assumes that the brightness function is linear in this neighbourhood [6].

Overall, each of these pre-processing techniques have their own, unique ability when tasked to clean image data before it is modelled, and more than one of these techniques can be used to clean images to create a high-quality dataset to provide the most accurate results possible for a model.

The dataset collected for our classification system consisted of already high-quality images, taken in daylight, so the image brightness was up to standard, as well as already pre cropped to a high standard, so any techniques that focused on colour correction, did not make much changes to the images. Although, the Geometric Transformation technique was used in the final iteration of the system, as after implementation into the system, higher accuracies were yielded. The pre-processing techniques used were ones built into the TensorFlow Python library, which augment the image data, such as RandomFlip, RandomZoom, and RandomRotation. These techniques are in line with the Geometric Tranformation technique discussed above, and apply random augmentation transformations to the dataset during training to aid the model in correctly classifying them.

References

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