I. Introduction

This report describes the designing and implementation of a Deep Learning model that is capable of classifying digital images of traffic signs. Traffic sign classification is used for example in cars to automatically provide information about the currently applicable traffic rules like the speed limit to the driver or an automated driving system. The type of Deep Learning model that was selected for this task is a Convolutional Neural Network (CNN). The following chapter contains a definition of the task at hand.

II. i. Task Definition

The goal of this project is to construct an appropriate Deep Learning model that is capable of classifying digital images of traffic signs, in such a way that each image is mapped to an integer that represents a class, such as “Speed limit 20” or “Turn right”. An appropriate model shall be found by testing a variety of architectures and parameter combinations of CNNs using an appropriate training data set that will be split into two parts, one for training and one for validation. The scope of this project was reduced to CNNs from the beginning, since the established literature suggests that they are most fit for the task of image classification (see for example chapter 5.5.6 of [1]). Next to the designing and implementation of the model, the evaluation of the same with appropriate test data and evaluation measures is another crucial part of this project. This will be further described in the following chapter.

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II. iv. Error Analysis

The error analysis of for this project consists of two experiments.

The first experiment: Previously, during the training of the two final models, the state of the two final models was saved after each of the 30 epochs of their training. This enabled us to apply each of these 30 \* 2 = 60 models to the test dataset and with the resulting accuracies and the training accuracies that were saved during the training process to gain knowledge on potentially present overfitting and thus the respective generalization ability of each of these 60 models. On the basis of this information, the final model was chosen.

The second experiment: In order to assess the fitness of the model to be deployed in a real-world scenario, the authors photographed traffic signs in the city of Lisbon and applied the final CNN to these images. The traffic signs selected for this approach were traffic signs that had at least similar counterparts in the datasets used for training and testing, which is made up of photos of German traffic signs. An example for a traffic sign where the Portuguese version is only similar to the German one is the one depicted in Figure 1. The results of this experiment were evaluated by comparing the predicted classes with the classes of the traffic signs that the authors found to be the German counterparts.

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III.i.2

Results of the first experiment: The model that the authors found to have the best combination of a high accuracy as well as a low amount of overfitting is the model with/without weights applied during the training process that was trained for zz epochs. It’s training accuracy is train\_acc and its test set accuracy is test\_acc. The difference of diff\_between\_train\_acc\_and\_test\_acc was found to be acceptable by the authors.

Results of the second experiment: Of the xx Lisbon traffic signs that were photographed by the authors yy were classified correctly by the final CNN. Additionally, even though there are some significant differences between the German and the Portuguese traffic sign shown in Figure 1, the final CNN was able to successfully classify photographies of this traffic sign. This shows the generalization ability of the final CNN and that it is versatile in different environments.

A sign with a bicycle on it

Description automatically generated with low confidence

Figure : Comparison of a Portuguese „bicycle“ traffic sign (left) and a German one (right).

# Bibliography

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| [1] | C. M. Bishop, Pattern Recognition and Machine Learning (Information Science and Statistics), Berlin, Heidelberg: Springer-Verlag, 2006. |