Info 213 Team Project

A Lightweight Convolutional Neural Network Model for Traffic Sign Classification Based on Enhanced LeNet-5 Network

Course	Data Science Programming II
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1. Background

Road safety is attracting the attention of many researchers around the world since it is indispensable in protecting human life. Driver assistance systems have played a very important role. For several years now, systems for the detection, classification, and recognition of road signs have become a very important research topic for researchers.

2. Motivation

Based on the background of road safety, classification and recognition of road signs have become a very important research topic for researchers. But it is quite hard for researchers to just use some formulas or equations to solve the problem. Fortunately, the rapid development of machine learning gives us the confidence to figure out the puzzle.

Machine learning allows us to easily feed the computer algorithm an immense amount of traffic sign data and have the computer analyze and make data-driven recommendations and decisions based on only the input data. If any corrections are identified, the algorithm can incorporate that information to improve its future decision-making. After the model construction is done, we can put any traffic sign data to get the name of them.

3. The Advantages in Real World

Traffic sign classifiers can be used for traffic sign recognition system which can do great help to driverless vehicles. Moreover, a road and traffic sign classifier system could in principle be developed as part of an Intelligent Transport Systems (ITS) that continuously monitors the driver, the vehicle, and the road in order, for example, to inform the driver in time about upcoming decision points regarding navigation and potentially risky traffic situations.

4. The Data

We are using the German Traffic Sign Recognition Benchmark (GTSRB) database(url:https://benchmark.ini.rub.de/gtsrb_dataset.html) as the dataset. It is an image classification dataset. And the images are photos of traffic signs which are classified into 43 classes.

In the data pre-processing section:

1. **Loading data**
2. **Resizing.**

   After loading the data, it is essential to resize the shape of the data to modify the machine-learning algorithm. As the network we built, the data should be resized to 32 x 32.
3. **Grayscaling**

   The color of the traffic sign is not very important, and for the embedded implementation using the webcam, lightness is more significant than color, so the RGB space of the images is converted to grayscale.

4. **Normalization**

Map the pixel data of images to the interval [0, 1] in the form of float numbers, which is beneficial to the training of the model.

5. **Histogram equalization**

Histogram equalization is used afterwards to improve the image contrast, especially for grayscale images. Adjusting the histogram of the training images effectively helps to make the training process more dynamic.

5. Input and Output

The input is the traffic sign figure, the output is the name and prediction probability of the traffic sign.

6. Steps of Machine-learning

The ideal machine-learning algorithm we chose is CNN(Convolutional Neural Network) which is powerful for image processing, and for more specific, the machine-learning algorithm is Lightweight Enhanced Lenet-5 network.

The training section is mainly using Keras in python3.

The basic framework is that there are 4 convolution layers, 2 max-pooling layers, 2 dropout layers, 2 batch normalization layers, and 2 full connection layers.

There are two successive convolution layers (C1, C2); each convolution layer is followed by a Batch Normalization layer with a LeakyReLU activation function and finally a max-pooling layer(S3).

After the first max-pooling layer, there are also two successive convolution layers (C4, C5); each convolution layer is still followed by a Batch Normalization layer with a LeakyReLU activation function and finally a max-pooling layer(S6) with DropOut regularization.

After the data from the last max-pooling layer flatten(H7) whose nodes are equal to 480, there is a hidden layer(H8) whose nodes are equal to 500, followed by the Batch Normalization layer with LeakyReLU function and DropOut regularization.

The output layer contains 43 nodes, which are the number of classes for the traffic sign data.

For training, the training dataset is split into 20% validation data and 80% training data.

Moreover, there are some parameters for the algorithm:

The alpha parameter for LeakyReLU is 0.1.

The rate parameter for DropOut is 0.5.

The optimizer for compiling the model is Adadelta.

The initial learning rate is set to 1.0.

The batch size for training is set to 20.

7. Project in A Figure

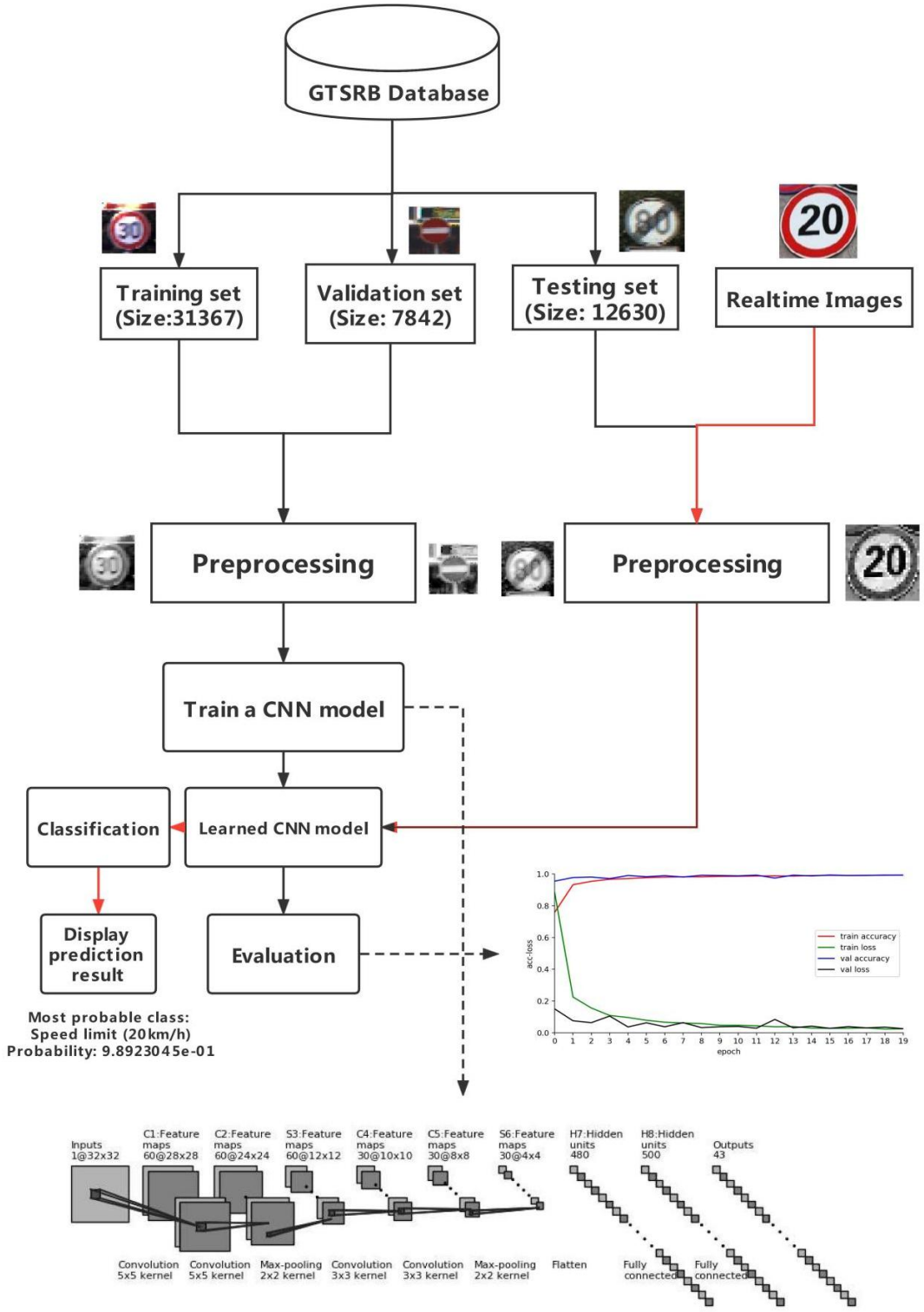

Figure 1. Whole progress in machine learning and its details

8. Reference

Zaibi, Ameur & Anis, Ladgham & Sakly, Anis. (2021). A Lightweight Model for Traffic Sign Classification Based on Enhanced LeNet-5 Network. Journal of Sensors. 2021. 10.1155/2021/8870529.