Project 3 – Traffic Sign Classification

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Data Set Summary & Exploration

Provide a basic summary of the data set. In the code, the analysis should be done using python, numpy and/or pandas methods rather than hardcoding results manually.

I used the numpy and matplotlib library to calculate summary statistics of the traffic signs data set:

* The size of training set is 34799

* The size of the validation set is 4410

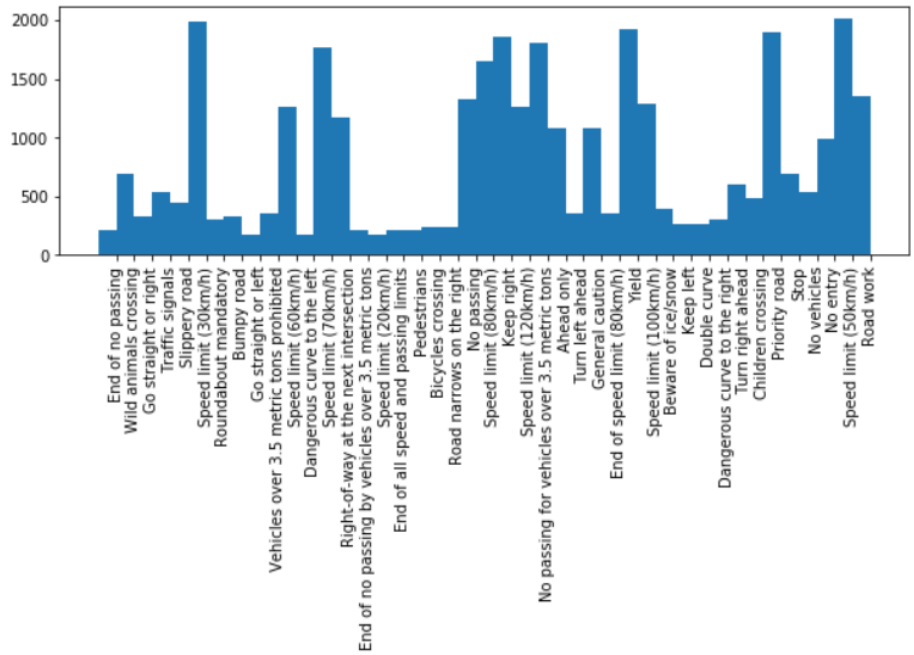
* The size of test set is 12630

* The shape of a traffic sign image is 32 x 32 x 3

* The number of unique classes/labels in the data set is 43

Include an exploratory visualization of the dataset.

Here is an exploratory visualization of the data set. It is a bar chart showing how the data is divided into different classes. The horizontal label is the number of classes and the vertical label is the sample number for each class.



Design and Test a Model Architecture

Describe how you preprocessed the image data. What techniques were chosen and why did you choose these techniques? Consider including images showing the output of each preprocessing technique. Pre-processing refers to techniques such as converting to grayscale, normalization, etc.

As a first step, I decided to convert the images to grayscale in order to reduce the dimension of the images. Later, the images were normalized using mean normalization. Both were done in order to reduce training complexity.

Describe what your final model architecture looks like including model type, layers, layer sizes, connectivity, etc.) Consider including a diagram and/or table describing the final model.

My final model consisted of the following layers:

1. Layer 1: Convolutional. Input = 32x32x1. Output = 28x28x6 with reLU activation
2. Pooling. Input = 28x28x6. Output = 14x14x6.
3. Layer 2: Convolutional. Output = 10x10x16 with reLU activation
4. Pooling. Input = 10x10x16. Output = 5x5x16.
5. Flatten. Input = 5x5x16. Output = 400.
6. Layer 3: Fully Connected. Input = 400. Output = 120 with reLU activation
7. Layer 4: Fully Connected. Input = 120. Output = 84 with ReLU activation
8. Layer 5: Fully Connected. Input = 84. Output = 43.

Describe how you trained your model. The discussion can include the type of optimizer, the batch size, number of epochs and any hyperparameters such as learning rate.

To train the model, I used the following parameters.

1. Learning rate = 0.0001.
2. EPOCHS = 150
3. BATCH_SIZE = 128
4. dropout = 0.5
5. mu = 0
6. sigma = 0.1
7. Optimizer = Adam

Describe the approach taken for finding a solution and getting the validation set accuracy to be at least 0.93. Include in the discussion the results on the training, validation and test sets and where in the code these were calculated. Your approach may have been an iterative process, in which case, outline the steps you took to get to the final solution and why you chose those steps. Perhaps your

solution involved an already well known implementation or architecture. In this case, discuss why you think the architecture is suitable for the current problem.

The approach taken was to increase the number of iterations from 10 to 150, and decrease the learning rate from 0.001 to 0.0001. This means that the convergence would be better for each epoch, and the resulting accuracy would be the specified value.

My final model results were:

* training set accuracy of **0.99 (99 %)**

* validation set accuracy of **0.94 (94%)**

* test set accuracy of **0.925 (92.5%)**

If an iterative approach was chosen:

* What was the first architecture that was tried and why was it chosen?

The first architecture was the one given in the lectures, in order to understand how it works on the given dataset

* What were some problems with the initial architecture?

The initial architecture had no dropout in it. The modified architecture contained a dropout which helped in training of the dataset.

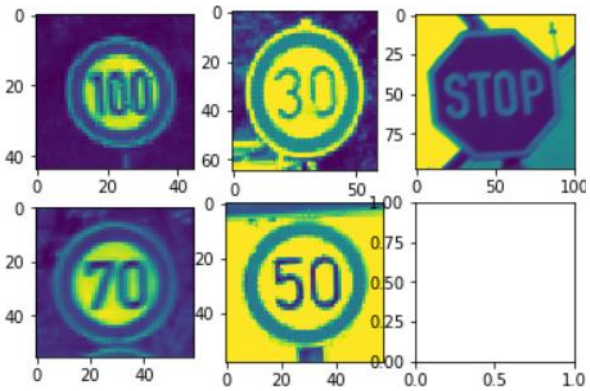
* Which parameters were tuned? How were they adjusted and why?

Number of epochs were increased to 150, given the size of the dataset. Learning rate was reduced to 0.0001, batch size was kept same.

Test a Model on New Images

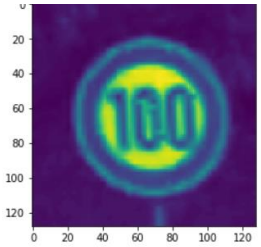
Choose five German traffic signs found on the web and provide them in the report. For each image, discuss what quality or qualities might be difficult to classify.

Here are five German traffic signs that I found on the web:

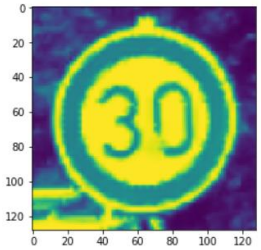


Discuss the model's predictions on these new traffic signs and compare the results to predicting on the test set. At a minimum, discuss what the predictions were, the accuracy on these new predictions, and compare the accuracy to the accuracy on the test set

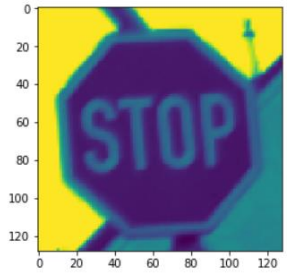
Here are the results of the prediction:



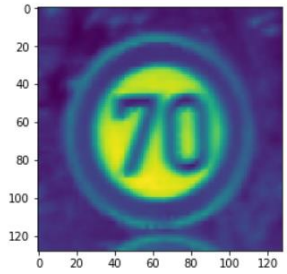
True label: Speed limit (100km/h)
Top 5: Speed limit (100km/h), Speed limit (20km/h), Speed limit (30km/h), Speed limit (50km/h), Speed limit (60km/h)



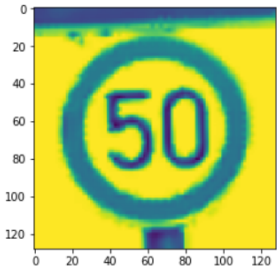
True label: Speed limit (30km/h)
Top 5: Speed limit (30km/h), Speed limit (20km/h), Speed limit (50km/h), Speed limit (60km/h), Speed limit (70km/h)



True label: Stop
Top 5: Stop, Speed limit (20km/h), Speed limit (30km/h), Speed limit (50km/h), Speed limit (60km/h)



True label: Speed limit (70km/h)
Top 5: Speed limit (70km/h), Speed limit (20km/h), Speed limit (30km/h), Speed limit (50km/h), Speed limit (60km/h)

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True label: Speed limit (50km/h)
Top 5: Speed limit (50km/h), Speed limit (20km/h), Speed limit (30km/h), Speed limit (60km/h), Speed limit (70km/h)
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The model was able to correctly guess all 5 of the 5 traffic signs, which gives an accuracy of 100%.