Project: Traffic Sign Classifier

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Data Set Summary & Exploration

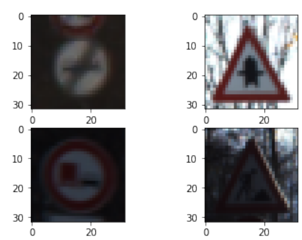
1. *Provide a basic summary of the data set.*

   I used the pandas library to calculate the following summary statistics of the traffic signs data set:

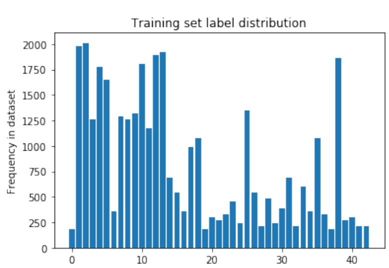
   - The size of training set is 34799
   - The size of the validation set is 4410
   - The size of test set is 12630
   - The shape of a traffic sign image is 32 X 32
   - The number of unique classes/labels in the data set is 43

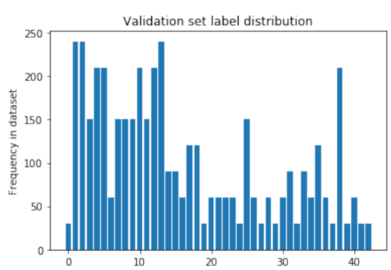
2. *Include an exploratory visualization of the dataset.*

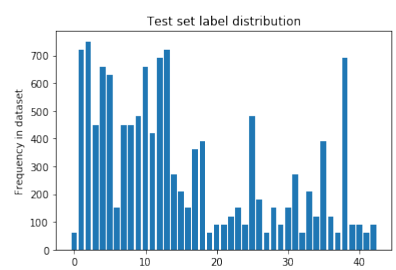
   Here is a sample of four images from the training dataset.



   The following three graphs show the distribution of label frequency in the training, validation, and test datasets.



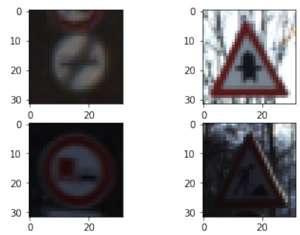




Design and Test a Model Architecture

1. *Describe how you preprocessed the image data.*

   The images were first converted to grayscale. This was calculated using a simple RGB value average for each pixel. After that, the pixel data was normalized to have zero mean and equal variance. Here are the same four images from above after the preprocessing steps



2. *Describe what your final model architecture looks like.*

Layer	Description
Input	32x32x1 grayscale image
Convolution 5x5	1x1 stride, valid padding, outputs 28x28x64
RELU	
Max pooling	2x2 stride, outputs 14x14x64
Convolution 5x5	1x1 stride, valid padding, outputs 10x10x128
RELU	
Max pooling	2x2 stride, outputs 5x5x128
Flatten	input 5x5x128, output 3200
Droput	Keep probability = 0.5
Fully connected	inputs 3200, outputs 400
RELU	
Fully connected	inputs 400, outputs 120
RELU	
Droput	Keep probability = 0.5
Fully connected	inputs 120, outputs 84
RELU	
Fully connected	inputs 84, outputs 43

3. *Describe how you trained your model.*

   The model was trained using the Adam optimizer using a cross entropy loss function. During training, the data was run through 10 times (10 epochs), the batch size was 128, and the learning rate was 0.001.

4. *Describe the approach taken for finding a solution and getting the validation set accuracy to be at least 0.93.*

   An iterative approach was taken to achieve the desired validation accuracy. I first started with the standard LeNet architecture. The accuracy were not high enough. I decided to then add dropouts to hopefully improve those numbers. The accuracy in the training sets were getting very high at that point, so I decided to increase the feature maps in the convolution layers, as well as add an additional fully connected layer to help with that. The desired accuracy was then achieved.

Test a Model on New Images

1. *Choose five German traffic signs found on the web. For each image, discuss what qualities might be difficult to classify.*

   In the second and fifth images, the unusual backgrounds could make the images difficult to classify. There are also differences in how zoomed in the signs are - the third image is quite zoomed in, while the fifth is zoomed out. Another difficulty in alll the images is the aspect ratio. When they are resized to be square, the images could become distorted and hence harder to classify.

2. *Disucss the model's predictions on these new traffic signs and compare the results to predicting on the test set.*




The correct labels for the data are $[4, 11, 13, 25, 33]$. The predicted values were $[40, 11, 13, 25, 35]$. The accuracy was thus **60%**.

This accuracy is by far smaller than the validation accuracy. This is probably due to the factor pointed out above. Another factor would be the dropouts in the network architecture: they don't guarantee that all learned knowledge is being used in the prediction.

3. *Describe how certain the model is when predicting on each of the five new images by looking at the softmax probabilities for each prediction.*

   The model seemed to be quite sure about only the second image. For the first image, we can see that the top five predictions were all over the place - indeed if we look at the processed and scaled version of the image, it is very distorted. While the fifth image was not classified correctly either, the top predictions had similar characteristics to the real answer.