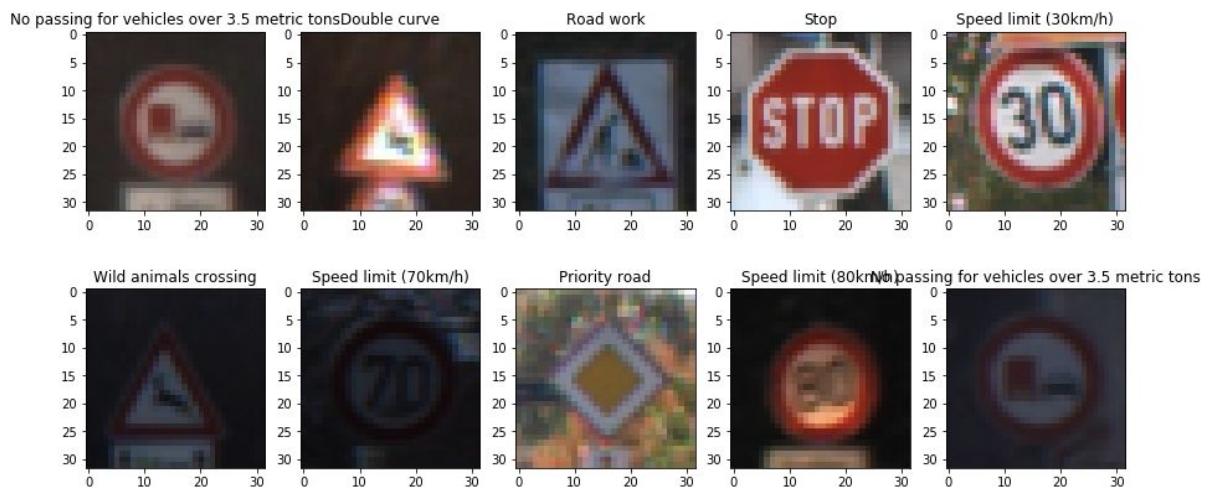


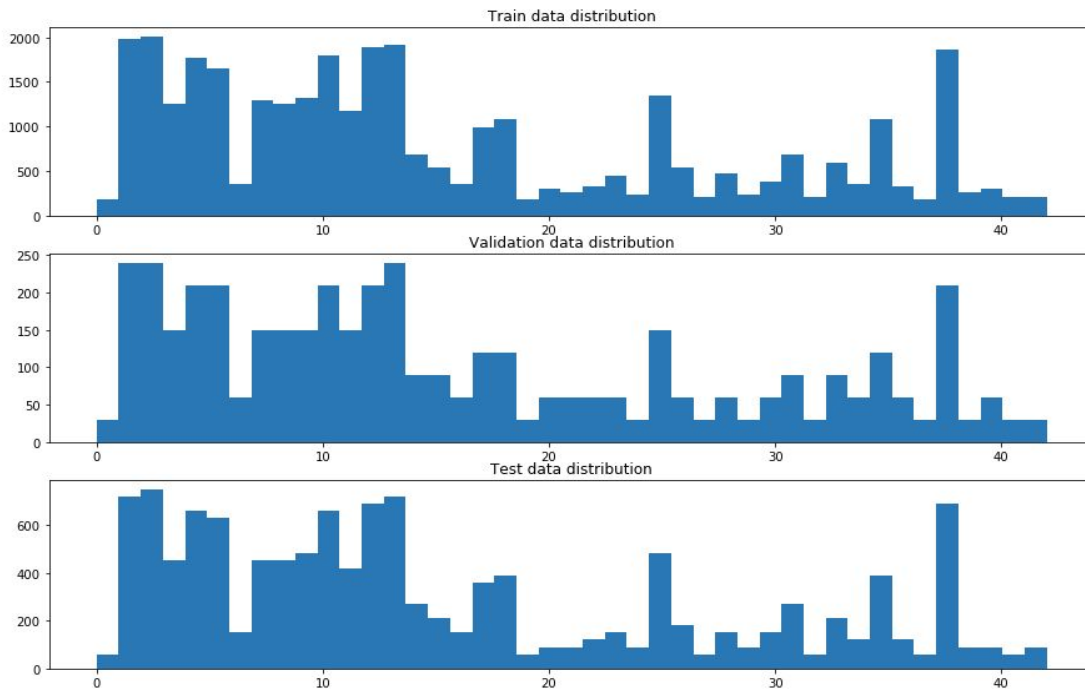
Data Set Summary & Exploration

Summary statistics of the traffic signs data set:

- Number of training examples = 34799
- Number of validation examples = 4410
- Number of testing examples = 12630
- Image data shape = (32, 32, 3)
- Number of classes = 43

Some images and distribution of dataset:



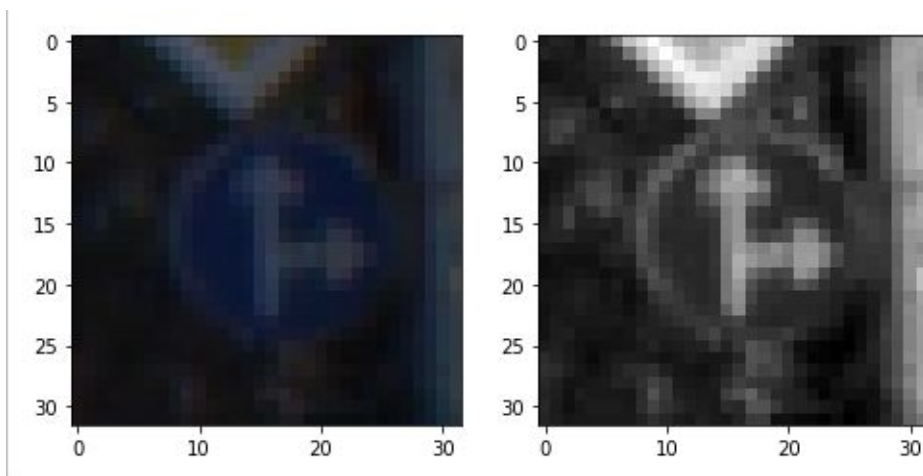


The graph shows that distribution of traffic signs are similar between training, validation and testing set.

Data Preprocessing

Apply grayscale

Applying grayscale will lose image information but make it easier for the network to learn. The remaining information is enough to train a accuracy classifier.



Apply Normalization

Normalizing pixel values to $(-1,1)$ helps the network converge.

Model Architecture

The first test solution is LeNet-5 Lab Solution, the validation accuracy is about 85%.

Modified LeNet-5 Lab Solution get the new model:

Layer	Description
Input	32x32x1 grayscale image
Convolution 5x5	1x1 stride, valid padding, outputs 28x28x6
RELU	
Max pooling 2x2	2x2 kernel size, 2x2 stride, outputs 14x14x6
Convolution 5x5	1x1 stride, valid padding, outputs 10x10x6
RELU	
Max pooling 2x2	2x2 kernel size, 2x2 stride, outputs 5x5x16
Convolution 5x5	1x1 stride, valid padding, outputs 1x1x400
RELU	
Flatten and concatenate	$1 \times 1 \times 400 + 5 \times 5 \times 16 = 800$

Dropout	keep 50%
Fully connected	inputs 800, outputs 43

Train and Test Model

With Epoch size equal 60, Batch size equal 100.

Learning rate is 0.0009.

- validation accuracy : 96.0%
- test set accuracy : 94.4%

Test Model on New Images

6 new test signs found online:



Visualization of softmax, possible reasons for head to classify second image might be low contrast and unusual block on the left bottom.

