Traffic Sign Recognition

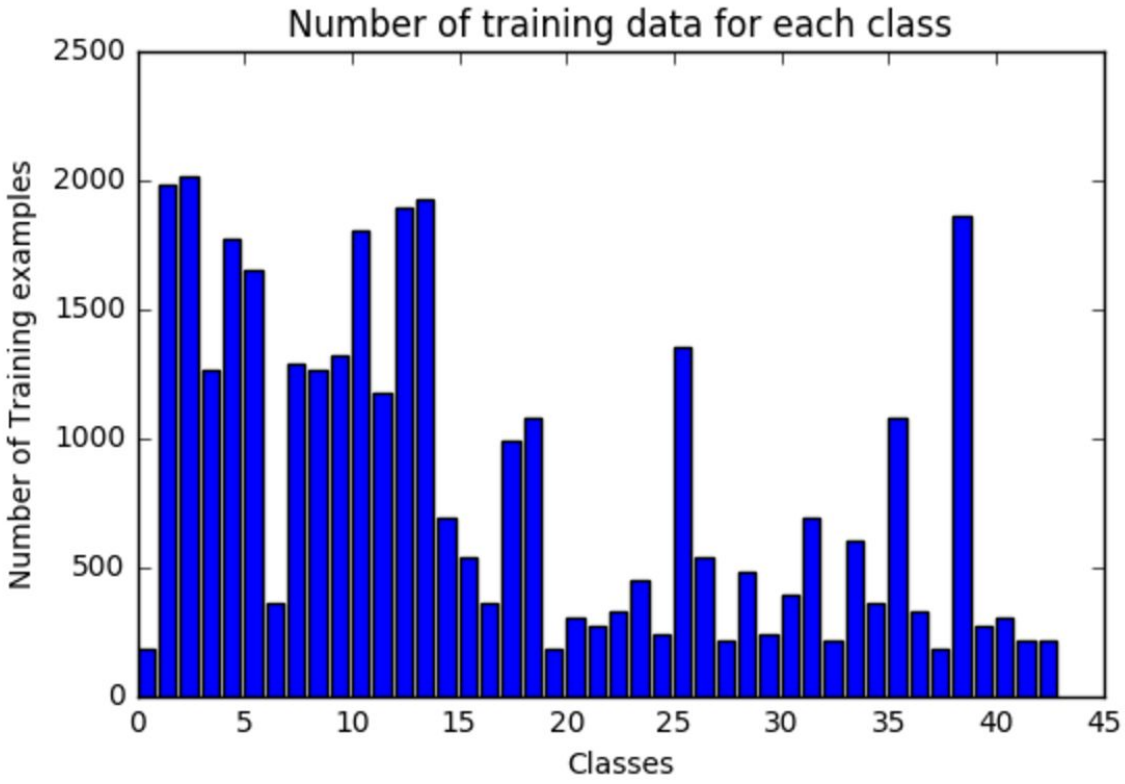
Data Set Summary & Exploration:

I used numpy and matplotlib libraries for basic data set analysis and exploration :

- 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, 32, 3).
- The number of unique classes/labels in the data set is 43.

The figure below represents a visualization of data set.

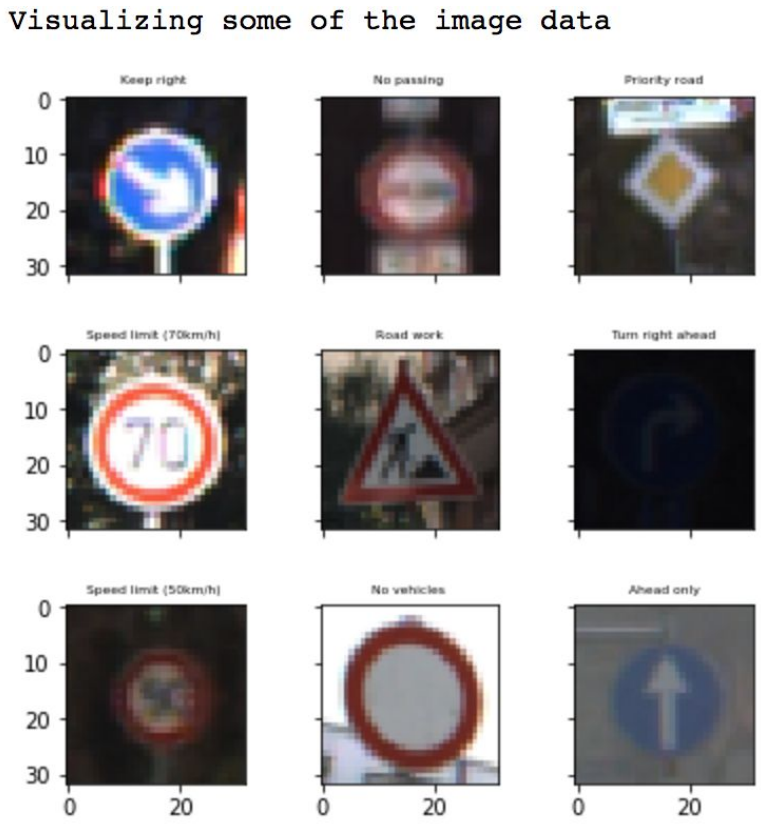
```
Distribution of Training data
```



Design and Test a Model Architecture:
The design and test of model architecture is briefly divided into three parts. The first part is data augmentation. The second one is image preprocessing and last one is using Lenet and training it for different epochs.

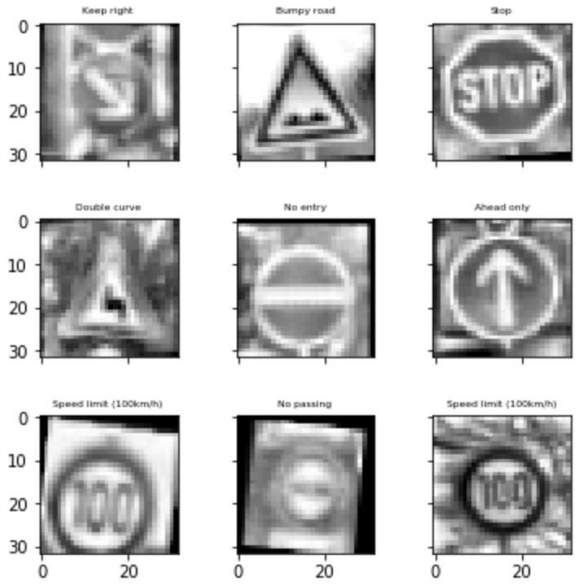
Data Augmentation :
In process of data augmentation, three different methods are used. These are rotation, translation and sheer. These methods were chosen so as to incorporate images when seen from different view. Depending upon viewpoint, an image can look different and this difference is often some translation and rotation. To make model robust, sheer is also introduced. The sheer effect helps model to learn low level detail as it distorts the image by some small degree.

Data preprocessing :
As per preprocessing, an image is converted to grayscale and center normalize. As per Yann Lecun, color information is not important to achieve higher accuracy and thus I also decided to go with it. Center normalization helps the model to converge faster.



The image above shows traffic sign before preprocessing.

```
Visualizing some of the image data
```



The image shown above is after translation, rotation, shearing, grayscale and center normalization.


```
*****************
Min Count :  1080
Max Count :  4140
*****************
```

The distribution of augmented data is show above.

Model Architecture:
The following model architecture is used for our purpose.

Input : (32, 32, 1)

Layer	Description
Convolution Layer (5, 5)	(1, 1) Stride , padding : 'VALID' Output : (28, 28, 6)
RELU	
Max Pooling (2, 2)	(2, 2) Stride, padding : 'VALID' Output : (14, 14, 6)
Convolution Layer (5, 5)	(1, 1) Stride , padding : 'VALID' Output : (10, 10, 16)
RELU	
Max Pooling (2, 2)	(2, 2) Stride, padding : 'VALID' Output : (5, 5, 16)
Fully connected Layer	120
RELU	
Fully connected Layer	84
RELU	
Fully connected Layer	43
Softmax	

I trained my model for about 40 epochs so as to avoid overfitting. I used a learning rate of 0.001 and batch size of 128.

Model Performance:
Validation Accuracy : 96.2%
Test Accuracy : 94.6%

Lenet is used as model architecture as it has been widely used in such application and have proved successful. This model is also minimalistic having fewer parameters. This enables the model to train very quickly and also lowers the risk of model overfitting.

Test Model on new Images

Following are new images used for testing:

Most of these images are clear and thus the model should not find any difficulty in identifying them.

Children crossing might be difficult as it may be confused with other signs and road work where human involves as well as pedestrian crossing.

Right of way at the next intersection is slightly dark but with the preprocessing, I have used, it should be easy for the model identify it.

Predictions:

Here is the result of prediction on these images:

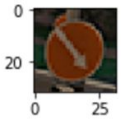
Image	Prediction
Roundabout mandatory	Roundabout mandatory
Keep right	Keep right
Stop	Stop
Speed Limit (20km/hr)	Speed Limit (20km/hr)
No entry	No entry
Turn Left ahead	Turn Left ahead
Keep Left	Keep Left

Right of way at next intersection	Right of way at next intersection
Yield	Yield
Children Crossing	Road narrows on right

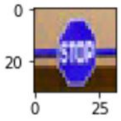
Softmax Probabilities:

The softmax probabilities of these predictions are given below:

```
True Sign :  Roundabout mandatory
Predicted Correctly

********** Top predictions **********
Roundabout mandatory      100.0 %
Speed limit (100km/h)     5.57537e-07 %
Speed limit (70km/h)      1.29433e-08 %
Speed limit (30km/h)      1.56605e-09 %
Speed limit (120km/h)     5.17582e-12 %
```

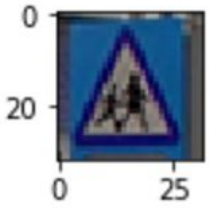


```
True Sign :  Keep right
Predicted Correctly

********** Top predictions **********
Keep right        100.0 %
Turn left ahead           1.25572e-18 %
Yield     7.0411e-19 %
Priority road     1.16969e-19 %
Speed limit (30km/h)      5.09141e-23 %
```



```
True Sign :  Stop
Predicted Correctly

********** Top predictions **********
Stop      99.9999 %
Roundabout mandatory      7.47916e-05 %
Speed limit (30km/h)      6.44143e-09 %
No entry          6.41821e-09 %
Speed limit (50km/h)      1.02095e-11 %
```

The softmax probabilities of the one wrongly predicted.




```
True Sign :  Children crossing
Predicted Wrongly

********** Top predictions **********
Road narrows on the right        58.4982 %
Pedestrians      17.9402 %
Road work        12.3297 %
General caution          10.6379 %
Children crossing        0.592531 %
```

Accuracy on these images = 90 %