Project Writeup/README

Traffic Sign Recognition

The process involves the following steps...

- Load the data set (see below for links to the project data set)
- Explore, summarize and visualize the data set
- Design, train and test a model architecture
- Use the model to make predictions on new images
- Analyze the softmax probabilities of the new images
- Summarize the results with a written report

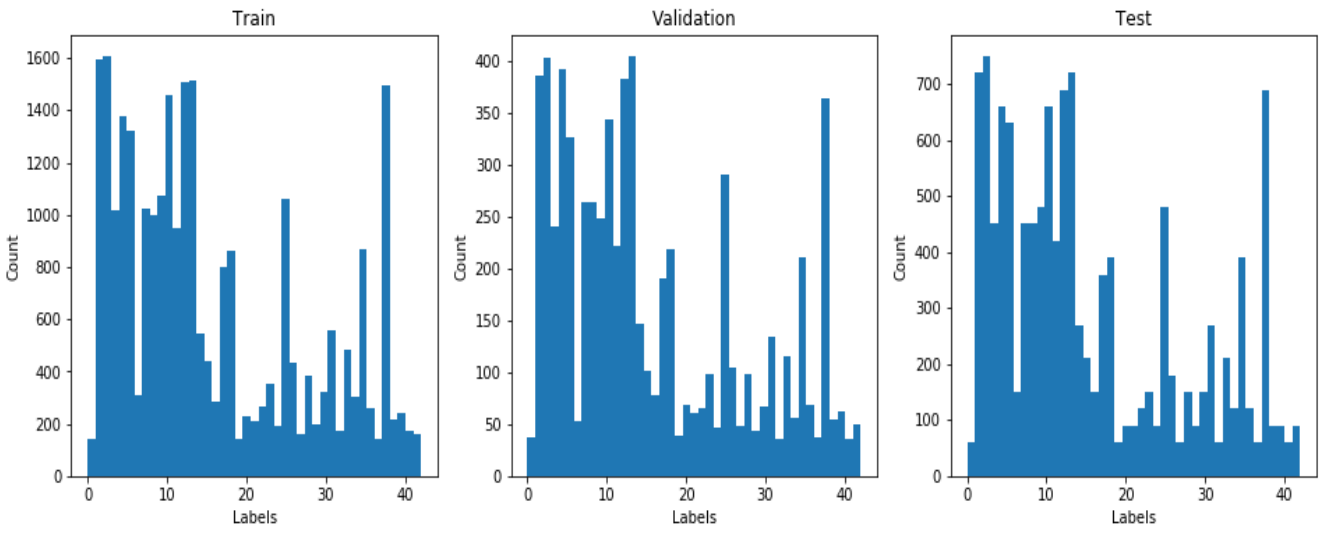
Files/Folders included:

- ✓ `Traffic_Sign_Classifier.ipynb`
- ✓ `Traffic_Sign_Classifier.html`
- ✓ `WRITEUP.pdf`
- ✓ `Test Images`

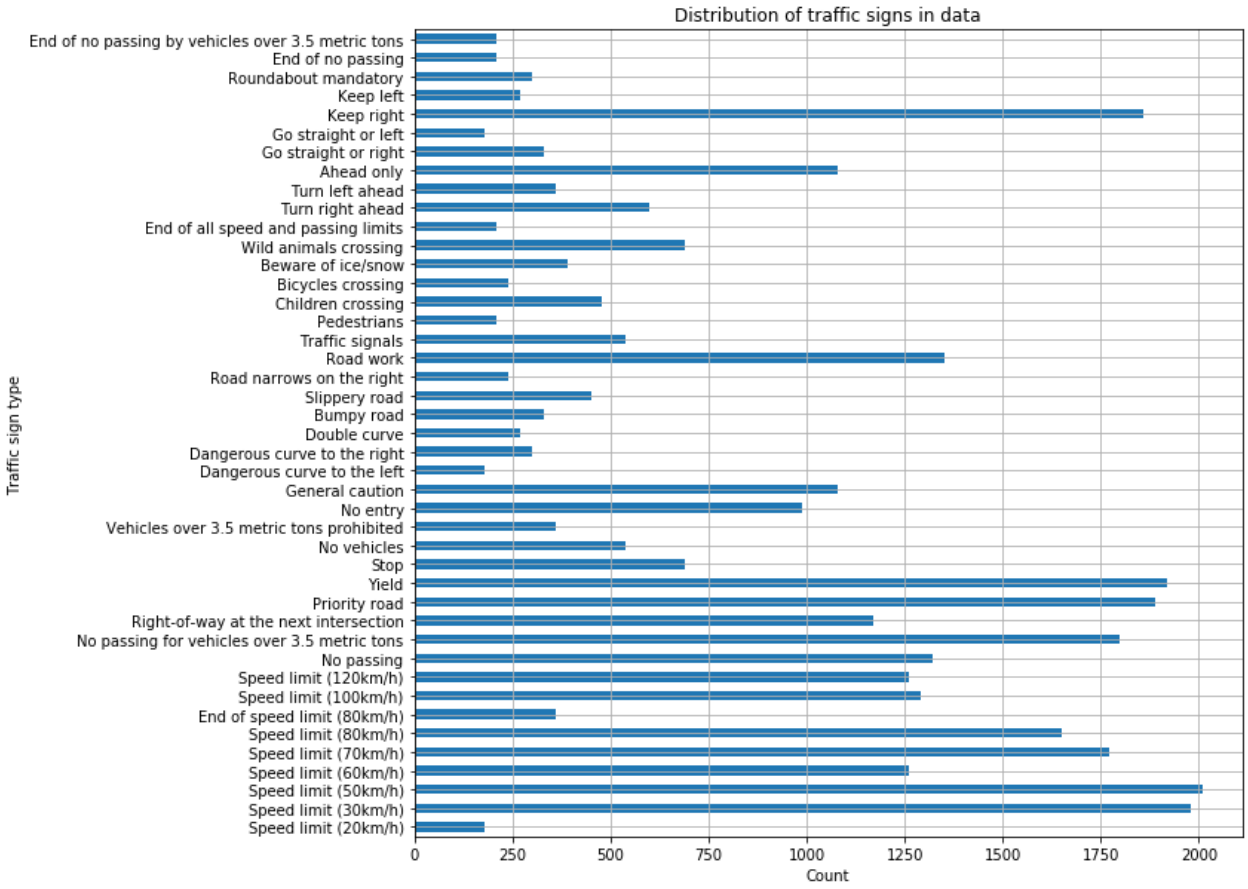
RUBRIC POINTS:

1. Data Set Summary & Exploration

- Size of the training set is : 34799 images of size (32,32)
- Size of the test set is : 12630 images of size (32,32)
- Then, we are slicing validation set from the training set, we take 20% of the training set. Hence, size of the validation set is : 6960 images of size (32,32)
- Image data shape is (32, 32, 3). Here, 3 is the no. of channels i.e. RGB in this case for color images.
- No. of classes : 43 i.e. 43 different types of traffic signs
- Distribution of traffic sign data in the datasets……

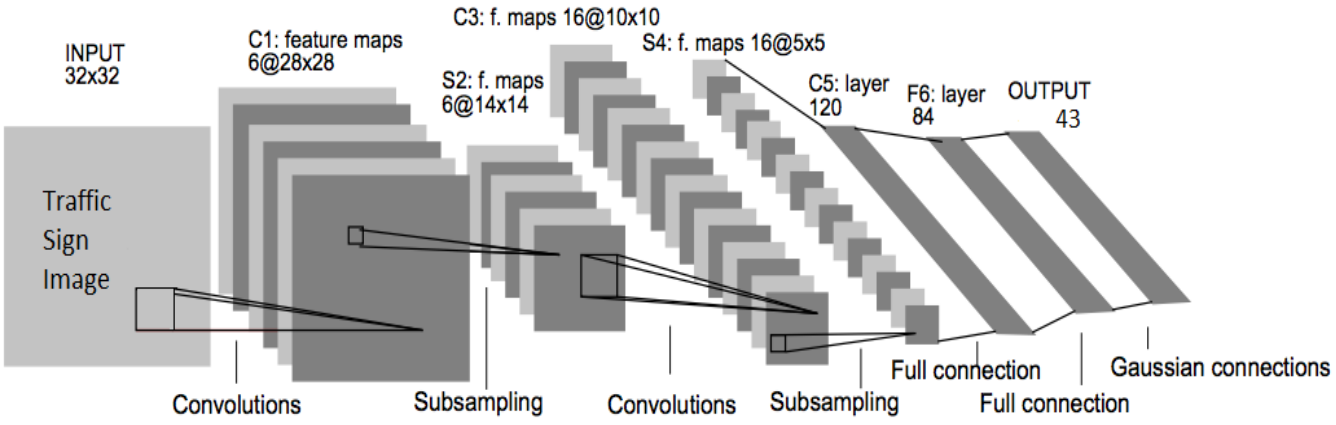


- Distribution of the traffic sign images per class……



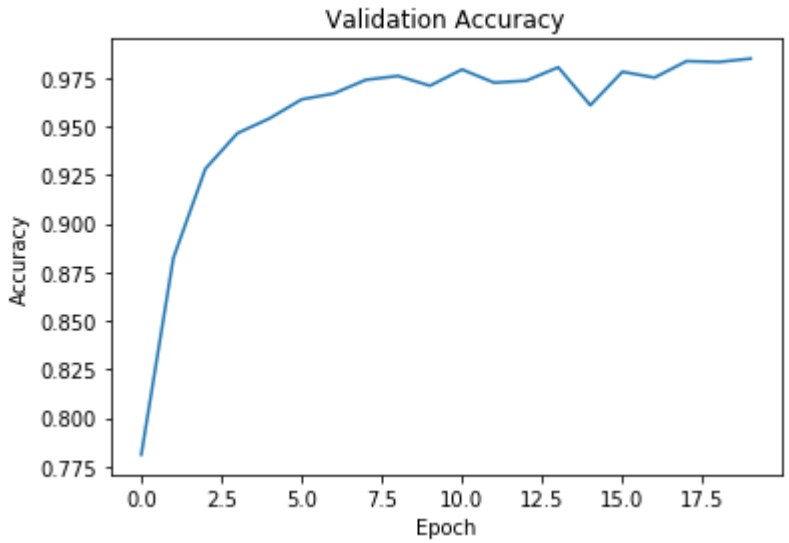
2. Designing and Testing the Model Architecture

- Images have been normalized to scale down the data to a better scale, i.e. having zero mean and equal variance.
- LeNet architecture has been used. The network is depicted below……



- The LeNet implemented is based upon the following paper by Yann LeCun….
  http://yann.lecun.com/exdb/publis/pdf/sermanet-ijcnn-11.pdf

- The model was trained using…..
  - Adam Optimizer to minimize the loss function
  - Epoch : 20
  - Batch Size : 64
  - Hyperparameters… mu : 0, sigma : 0.1
  - Learning rate : 0.001
- We run the training data through the training pipeline to train the model.
- After each epoch, we measure the loss and accuracy of the validation set.
- Maximum Validation Accuracy: **98.5%**



- The model checkpoint is saved.
- We then evaluate the model on the test set. It gives test accuracy of **91.4%**

3. Testing the Model on New Images

- The following German traffic signs downloaded from the internet have been used to test the model……

1.jpg(300x225)

2.jpg(640x480)

3.jpg(640x480)

4.jpg(640x480)

5.jpg(1600x1066)

6.jpg(460x450)

- The fifth image, 5.jpg might be difficult to classify because of large size or image effects or non-standard pedestrian icons.
- The actual labels of the signs are…..

Image	Sign Type	Label
1.jpg	Road work	25
2.jpg	Stop	14
3.jpg	Priority Road	12
4.jpg	No entry	17
5.jpg	Pedestrians	27
6.jpg	Speed limit (120km/h)	8

- Overall Accuracy on these new test images is **83.33%**
- As expected, the 5th image fails to get classified.
- The top 5 probabilities of the new test images are……

Image: 1.jpg

1. Road work - Probability: 0.8144193
2. Wild animals crossing - Probability: 0.14610314
3. Bicycles crossing - Probability: 0.03947703
4. Slippery road - Probability: 3.2619124e-07
5. Speed limit (80km/h) - Probability: 1.4778094e-07

Image: 2.jpg
1. Stop - Probability: 0.99139386
2. Road work - Probability: 0.008138403
3. Speed limit (60km/h) - Probability: 0.00024956363
4. No entry - Probability: 7.4283125e-05
5. Bicycles crossing - Probability: 6.9950445e-05

Image: 3.jpg
1. Priority road - Probability: 1.0
2. Yield - Probability: 4.3217787e-11
3. No passing for vehicles over 3.5 metric tons - Probability: 2.3713712e-11
4. No passing - Probability: 1.366222e-16
5. End of all speed and passing limits - Probability: 1.2293068e-17

Image: 4.jpg
1. No entry - Probability: 0.6594514
2. Stop - Probability: 0.34048912
3. Bicycles crossing - Probability: 5.775748e-05
4. Speed limit (30km/h) - Probability: 1.5726348e-06
5. Speed limit (20km/h) - Probability: 4.678121e-08

Image: 5.jpg
1. Right-of-way at the next intersection - Probability: 1.0
2. Pedestrians - Probability: 4.638571e-08
3. Beware of ice/snow - Probability: 8.947157e-11
4. Slippery road - Probability: 3.3830987e-11
5. Children crossing - Probability: 2.7232173e-11

Image: 6.jpg
1. Speed limit (120km/h) - Probability: 0.5996338
2. Speed limit (70km/h) - Probability: 0.3105269
3. Speed limit (50km/h) - Probability: 0.089732334
4. Keep left - Probability: 0.000106782456
5. Speed limit (30km/h) - Probability: 1.9371399e-07

Note: The 2nd probability for 5th image is correct label!

The model can be further improved by…

- Augmenting the training data
- Grayscale conversion of the training data
- Implementing in detail as described in the paper by Pierre Sermanet and Yann LeCun. [http://yann.lecun.com/exdb/publis/pdf/sermanet-ijcnn-11.pdf]
- Using different model architectures other than LeNet