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Project 2: Traffic Sign Classification

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Project Goal:

The Goals/Steps of the project are the following:

- **Dataset Exploration**
- **Design and Test a Model Architecture**
- **Test a Model on New Images**

Dataset Exploration:

Basic Summary: Following are the basic information of the traffic Sign Dataset:

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

Exploratory Visualization: The visualization performed on the dataset are :

- Displaying 8 random images from the dataset.

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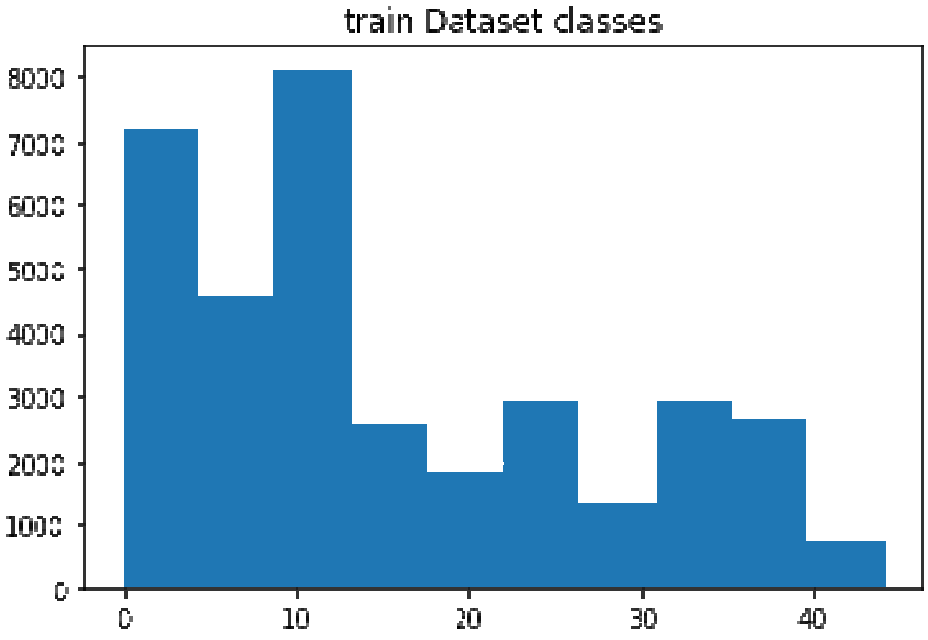
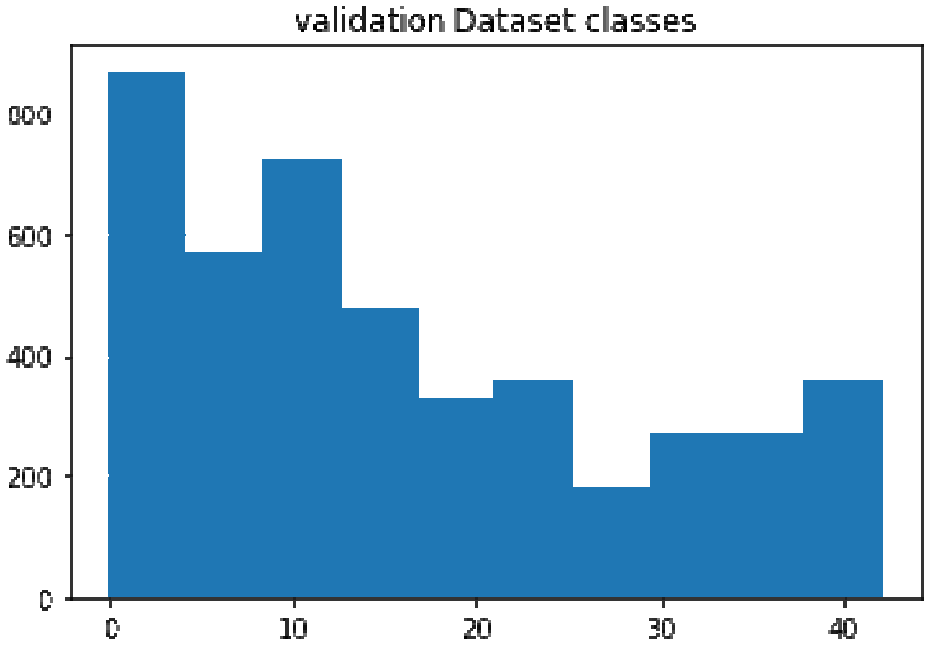
- Distribution of the 43 Labels in Train/Validation/Test Dataset





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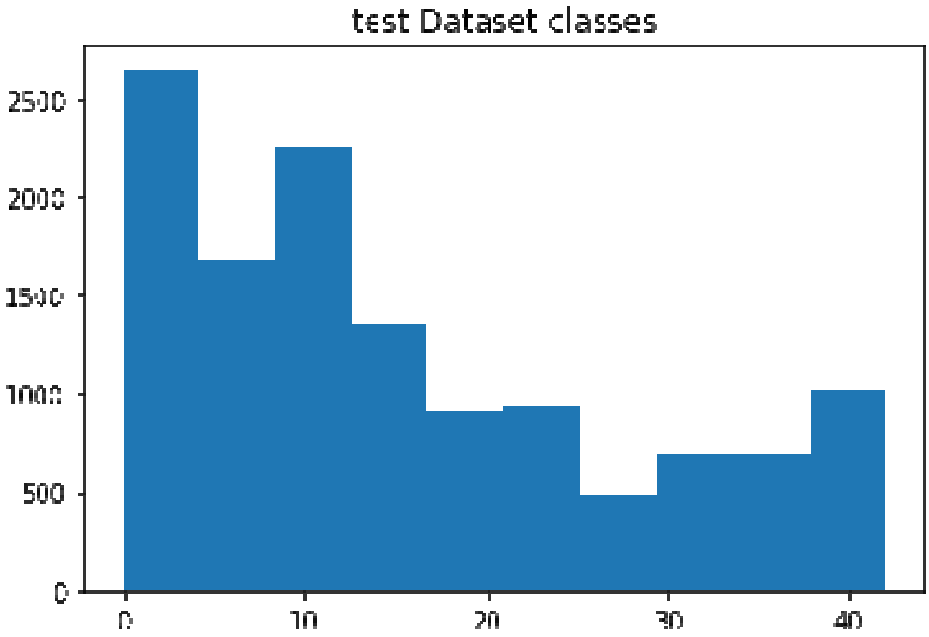

Design and Test a Model Architecture:

Preprocessing:

Convert to Grayscale: The Training set of images are first converted to grayscale as the LeNet architecture(on which the project is based upon) works best with grayscale images.

Normalize Images: The grayed images are then normalized to have 0 mean and equal variance for descending to low cost faster and in turn getting best weights and biases faster.

Parameters: mu = 0, sigma = 0.1

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Model Architecture: The model used is as follows:

Functions	Input	Filter/weights	Output
Conv1	32x32x1	5x5x1x16	28x28x16
Max_pool	28x28x16	1x2x2x1	14x14x16
Conv2	14x14x16	5x5x16x32	10x10x32
Max_pool	10x10x32	1x2x2x1	5x5x32
flatten	5x5x32		1x800
Full connection	1x800	800x240	1x240
Full connection	1x240	240x168	1x168
Full connection	1x168	168x43	1x43

Training Model:

Following are the values used as training parameters:

- Epoch = 20
- Batch Size = 128
- Learning rate = 0.001
- Optimizer used = AdamOptimizer

Convolution Neural Network is used to train the dataset. Probabilities for the logits are found using softmax function. These data is used as input to AdamOptimizer to find the minimum cost and correspondingly best weights and biases for testing.

Solution and Validation: Labels are one_hot encoded and then checked for correctness with the predictions made on validation dataset (using CNN). The validation accuracy hence found is 0.961.

Test accuracy = 0.939

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Test a Model on New Images:

Loading new web Images: 6 german traffic sign images are downloaded and cropped to fit 32x32 resolution. These images are then loaded and displayed.

Performance on New Images: The images are grayscaled and normalized using similar paramaters as before and the test accuracy is 0.833.

Softmax Probabilities: Softmax probabilities are calculated using tf.nn.top_k() and the results are as follows:

```
Softmax top 5 probability for Image 1 :
Probability 1 : (100.000%, label=14)
Probability 2 : (0.000%, label=39)
Probability 3 : (0.000%, label=29)
Probability 4 : (0.000%, label=2)
Probability 5 : (0.000%, label=31)

Softmax top 5 probability for Image 2 :
Probability 1 : (100.000%, label=25)
Probability 2 : (0.000%, label=24)
Probability 3 : (0.000%, label=18)
Probability 4 : (0.000%, label=20)
Probability 5 : (0.000%, label=31)

Softmax top 5 probability for Image 3 :
Probability 1 : (100.000%, label=38)
Probability 2 : (0.000%, label=34)
Probability 3 : (0.000%, label=0)
Probability 4 : (0.000%, label=1)
Probability 5 : (0.000%, label=2)
```

```
Softmax top 5 probability for Image 4 :
Probability 1 : (100.000%, label=23)
Probability 2 : (0.000%, label=10)
Probability 3 : (0.000%, label=19)
Probability 4 : (0.000%, label=20)
Probability 5 : (0.000%, label=30)

Softmax top 5 probability for Image 5 :
Probability 1 : (99.996%, label=27)
Probability 2 : (0.004%, label=18)
Probability 3 : (0.000%, label=24)
Probability 4 : (0.000%, label=25)
Probability 5 : (0.000%, label=11)
Softmax top 5 probability for Image 6 :
Probability 1 : (99.954%, label=2)
Probability 2 : (0.046%, label=1)
Probability 3 : (0.000%, label=31)
Probability 4 : (0.000%, label=3)
Probability 5 : (0.000%, label=5)
```

Model Certainity: As per the softmax probabilities, 5 images from new dataset are 100% accurately classified. 6th image is wrongly classified(correct label is 3). Therefore based on 6 images, the model is 83.3% certain.