Traffic Sign Recognition

#### Udacity SDC Term 1, P2

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#### 2017-05-11

**Convolutional Neural Network in Base TensorFlow**

The goals / steps of this project are the following:

* 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

**Rubric Points**

Here I will consider the [rubric points](https://review.udacity.com/#!/rubrics/481/view) individually and describe how I addressed each point in my implementation.

**Writeup / README**

1. **Provide a Writeup** 
   * You're reading it! and here is a link to my code: [github.com/cipher982/Traffic-Sign-Conv-Net-Recognition](https://github.com/cipher982/Traffic-Sign-Conv-Net-Recognition%20)

**Data Set Summary & Exploration**

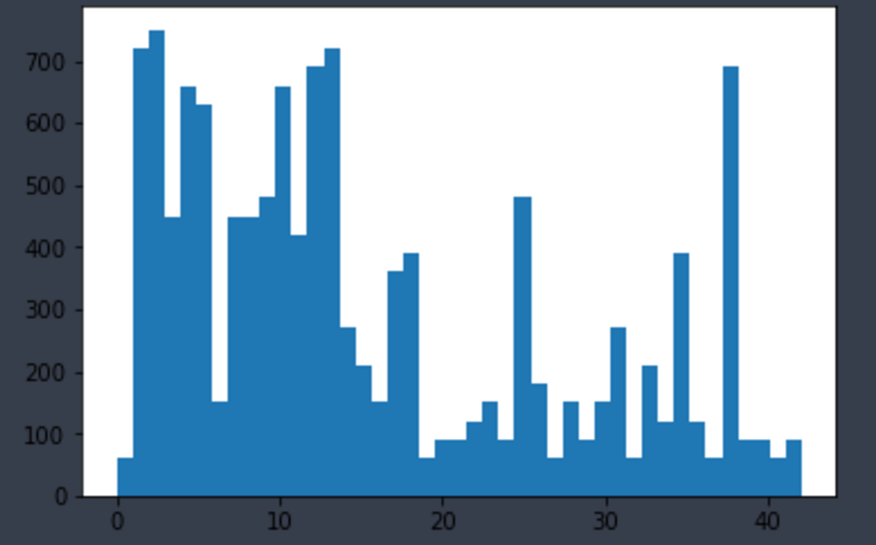
1. **Provide a basic summary of the data set. In the code, the analysis should be done using python, numpy and/or pandas methods rather than hardcoding results manually.**

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

* The size of training set is:
  + Before processing/augmentation: **34799**
* The size of the validation set is --
* The size of test set is **12630**
* The shape of a traffic sign image is **32x32** pixels, with **3** levels of color depth
* The number of unique classes/labels in the data set is **43**

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

Here is a bar chart showing how the data

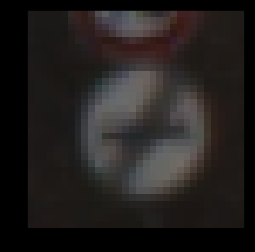
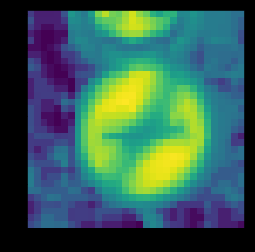


### Design and Test a Model Architecture

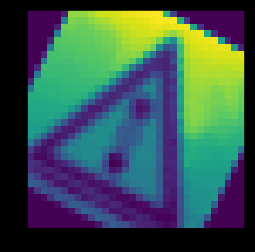
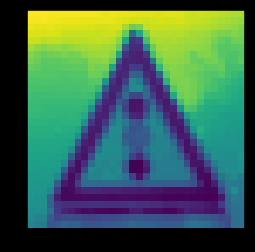
**1. Describe how you preprocessed the image data.**

I first converted to **one color channel** and **equalized the pixel brightness** average

* I did not want differences in lighting/exposure/brightness to bias or skew the training

Then I created additional training data from the original, as it is possible some signs may not be seen straight on. I did this by randomly rotating the images between **-30 and +30** degrees from original. The dataset ended up **3 times larger** than the original, at **104397**



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

My final model consisted of the following layers:

|  |
| --- |
| **Layer** |
| Input, 32 input |
| Convolution |
| Convolution |
| Convolution |
| Drop Layer, keep 70% |
| Convolution |
| Flatten |
| Fully Connected |
| Fully Connected |
| Fully Connected, 43 output |
| Dropout, keep 70% |

1. **Describe how you trained your model.** 
   * I used minibatches of size 150, with 7 total epochs. Trained over my Nvidia 960M GPU in laptop with tensorflow. Learning rate set at 0.001, sigma at 0.1, mu at 0.
2. **Describe the approach taken for finding a solution and getting the validation set accuracy to be at least 0.93.** 
   * My final results were the work of lots of random tweaking. Modifying parameters up/down until something started to work better. Switching from CPU to GPU allowed this process to go along much faster.
   * I started out adding two extra fully connected layers, but this did not seem to help much at all. Then I read some others had better luck adding convolutional layers instead.
   * I also came across a function for installing new layers, which took out a lot of the manual work of explicitly typing out layer by layer in TensorFlow.

|  |  |
| --- | --- |
| training set accuracy | .965 |
| validation set accuracy | .944 |
| test set accuracy | .921 |

~~Dropout was also added, but I did not use as much as others do, only a single layer keeping 90%.~~

Dropout was changed to 70%, and added another dropout after the last layer. Also, per recommendation I have used a placeholder for the dropout value, so that I can set it to no dropout when evaluating.

**Test a Model on New Images**

1. **Choose five German traffic signs found on the web and provide them in the report.**

I tried to find relatively simple, straight on images. They vary a bit on backgrounds, but otherwise looks quite similar.

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

Here are the results of the prediction (using probabilities from task below:

| **Image** | **Prediction** |
| --- | --- |
| Yield | Double Curve |
| Double Turn | Double Curve |
| Workers Ahead | Double Curve |
| 70 km/h | No passing for vehicles over 3.5 metric tons |
| Slippery Road | Double Curve |

The model was only able to guess a single correct sign, I imagine there’s some sort of error here as it just wants to guess the same thing over and over. (Except when I just run the evaluate code on the new data, then it says 60%, but I don’t know how to find the predictions from that)

**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.**

|  |  |
| --- | --- |
| **Sign** | **Predictions** |
| Yield | 1 : Double curve 0.931545  2 : Speed limit (80km/h) 0.0643561  3 : No passing for vehicles over 3.5 metric tons 0.00408106  4 : Wild animals crossing 1.4956e-05  5 : End of all speed and passing limits 9.77684e-07 |
| Double Turn | 1 : Double curve 0.999779  2 : No passing for vehicles over 3.5 metric tons 0.000211025  3 : Speed limit (80km/h) 9.87119e-06  4 : Dangerous curve to the right 8.32696e-09  5 : Ahead only 4.39636e-09 |
| Workers Ahead | 1 : Double curve 0.999988  2 : No passing for vehicles over 3.5 metric tons 1.12904e-05  3 : Go straight or left 2.01945e-07  4 : Speed limit (80km/h) 7.71859e-09  5 : End of no passing 7.01678e-09 |
| 70 km/h | 1 : No passing for vehicles over 3.5 metric tons 0.734856  2 : Double curve 0.264369  3 : End of no passing 0.000436071  4 : Speed limit (80km/h) 0.000308796  5 : Wild animals crossing 1.3751e-05 |
| Slippery Road | 1 : Double curve 0.996778  2 : No passing for vehicles over 3.5 metric tons 0.00311182  3 : No entry 9.51355e-05  4 : Go straight or left 5.567e-06  5 : Speed limit (80km/h) 3.93932e-06 |

It is very confident in the completely wrong signs, with the exception of one of them.