

## PROJECT SPECIFICATION

### Traffic Sign Classification

#### Files Submitted

CRITERIA	MEETS SPECIFICATIONS
Submission Files	The project submission includes all required files.

#### Dataset Exploration

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Dataset Summary	The submission includes a basic summary of the data set.
Exploratory Visualization	The submission includes an exploratory visualization on the dataset.

#### Design and Test a Model Architecture

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Preprocessing	The submission describes the preprocessing techniques used and why these techniques were chosen.
Model Architecture	The submission provides details of the characteristics and qualities of the architecture, including the type of model used, the number of layers, and the size of each layer. Visualizations emphasizing particular qualities of the architecture are encouraged.
Model Training	The submission describes how the model was trained by discussing what optimizer was used, batch size, number of epochs and values for hyperparameters.
Solution Approach	The submission describes the approach to finding a solution. Accuracy on the validation set is 0.93 or greater.

#### Test a Model on New Images

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CRITERIA	MEETS SPECIFICATIONS
Acquiring New Images	The submission includes five new German Traffic signs found on the web, and the images are visualized. Discussion is made as to particular qualities of the images or traffic signs in the images that are of interest, such as whether they would be difficult for the model to classify.
Performance on New Images	The submission documents the performance of the model when tested on the captured images. The performance on the new images is compared to the accuracy results of the test set.
Model Certainty - Softmax Probabilities	The top five softmax probabilities of the predictions on the captured images are outputted. The submission discusses how certain or uncertain the model is of its predictions.

### Suggestions to Make Your Project Stand Out!

Here are a few ideas for going beyond the requirements outlined in the rubric.

#### AUGMENT THE TRAINING DATA

Augmenting the training set might help improve model performance. Common data augmentation techniques include rotation, translation, zoom, flips, and/or color perturbation. These techniques can be used individually or combined.

#### ANALYZE NEW IMAGE PERFORMANCE IN MORE DETAIL

Calculating the accuracy on these five German traffic sign images found on the web might not give a comprehensive overview of how well the model is performing. Consider ways to do a more detailed analysis of model performance by looking at predictions in more detail. For example, calculate the [precision and recall](#) for each traffic sign type from the test set and then compare performance on these five new images..

If one of the new images is a stop sign but was predicted to be a bumpy road sign, then we might expect a low recall for stop signs. In other words, the model has trouble predicting on stop signs. If one of the new images is a 100 km/h sign but was predicted to be a stop sign, we might expect precision to be low for stop signs. In other words, if the model says something is a stop sign, we're not very sure that it really is a stop sign.

Looking at performance of individual sign types can help guide how to better augment the data set or how to fine tune the model.

#### CREATE VISUALIZATIONS OF THE SOFTMAX PROBABILITIES

For each of the five new images, create a graphic visualization of the soft-max probabilities. Bar charts might work well.

#### VISUALIZE LAYERS OF THE NEURAL NETWORK

See Step 4 of the Ipython notebook for details about how to do this.

