Files Submitted

CRITERIA	MEETS SPECIFICATIONS
Submission Files	[Download Jupyter Notebook from GitHub] Note: traffic sign images were too large to upload to GitHub

Dataset Exploration

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Dataset Summary	The submission includes a basic summary of the data set. Number of training examples = 34799 Number of testing examples = 12630 Number of validation examples = 4410 Image data shape = (32, 32, 3) Number of classes = 43
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. Preprocessing including normalizing data to range 0-1. I did not convert to grayscale as I wanted to see results in RGB.

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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. Input Layer 1: Convolutional. Input = 32x32x1. Output = 28x28x6 Activation Layer 1: Relu Pooling Layer 1: 2x2 kernel size, 2x2 stride, valid padding. Output = 14x14x6 Layer 2: Convolutional. Output = 10x10x16 Activation Layer 2: Relu Pooling Layer 2: 2x2 kernel size, 2x2 stride Flatten output Fully Connected Layer 1: y = xW + b Activation: Relu Fully Connected Layer 2: y = xW + b Activation: Relu Output Layer: Fully Connected Input = 84. Output = 43 Fully Connected Layer Output: y = xW + b
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. Submission #1 I chose the following model parameters: - Epochs = 15 (due to limited computer resources) - Batch Size = 128 - AdamOptimizer was used to minimize loss with learning rate of 0.001
Solution Approach	The submission describes the approach to finding a solution. Accuracy on the validation set is 0.93 or greater. Submission#2 I improved the accuracy of the model by changing images (converted to single channel grayscale, maximized contrast, and normalized) I chose the following model parameters: - Epochs = 20 (increased to better train model) - Batch Size = 128 - AdamOptimizer was used to minimize loss with learning rate of 0.001 EPOCH 17 ... Validation Accuracy = 0.926 EPOCH 18 ... Validation Accuracy = 0.928

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	EPOCH 19 ... Validation Accuracy = 0.932 EPOCH 20 ... Validation Accuracy = 0.936 Test Accuracy = 0.925 Submission #1 To improve the accuracy of the model, I would convert the images to grayscale, augment the dataset with more imagesl Increased the number of epochs. Model had Test Accuracy = 0.864 Training Accuracy = 0.965 in gray scale.

Test a Model on New Images

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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. Collected 5 images. The images are downloaded from the internet. The model seems to work fine when the sign is central and focused. It doesn't seem to perform well when the sign does not occupy the vast majority of the image.
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. Accuracy of new images: 60.0 %(3 out of 5) Test Accuracy = 87.3%
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. Top 5 values of 13: [1. 0. 0. 0. 0.] / indices [13 0 1 2 3] Top 5 values of 17: [1. 0. 0. 0. 0.]/ indices [17 0 1 2 3] Top 5 values of 25: [1. 0. 0. 0. 0.] / indices [25 0 1 2 3] Top 5 values of 29: [1. 0. 0. 0. 0.] / indices [17 0 1 2 3] Top 5 values of 33: [1. 0. 0. 0. 0.] / indices [35 0 1 2 3]