Assignment 4
Traffic Sign Recognition using Deep Neural Network

Kshitij Shah – ks1223

Instruction of running the code

Code is organized as separate files as per instructed. However, only main.py is executable. On running 'main.py' it asks to select the model to use. 'batch size', 'epoch' and other parameters can be adjusted in main.py

The files 'train_baseline.py', 'train_enhanced1.py' and 'train_enhanced2.py' trains the respective model. All the three models reside in the 'model.py' file.

For testing a model pretrained by me, run 'test_loadmodel.py'. This file is runnable and by default uses pretrained baseline model. Other models can also be selected by modifying the path in the file.

Accuracy and Training time

All models are trained on GTX 1070 GPU using Tensorflow backend.

Model	Epochs	Batch size	Training Time (seconds)	Accuracy
Baseline	5	32	75.65	95.38%
Baseline	15	32	225.28	97.13%
Baseline	20	32	305.45	97.31%
Baseline	30	32	445.77	**97.34%**
VGG16 (Enhanced 1)	5	32	269.85	97.03%
VGG16 (Enhanced 1)	10	32	536.17	**97.74%**
Enhanced 2	15	32	294.97	97.08%
Enhanced 2	20	32	391.41	96.96%
Enhanced 2	30	32	695.78 *	**97.11%**

*Removal of power supply slowed down the GPU during this during training. It should be less in ideal condition.

Some experiments with batch size and learning rate were also performed but are not properly recorded. Increase in batch size improves training time marginally, but also reduces accuracy a bit (<0.5%)

Answers

1. **What is epoch? What is the relation between an epoch and an iteration?**

An epoch is a complete pass through a given dataset. In other words, one forward pass and one backward pass of all the training examples. Iteration is a pass using examples equal to batch size. If we have 1000 samples and our batch size is 50, each epoch will have 1000/50 = 20 iterations. If the batch size equal to number of samples there would be only one batch per epoch. And number of epoch will be equal to number of iterations.

$$epoch * samples = iterations * batch\ size$$

2. **What is learning rate? What is the effect if increasing it?**

Learning rate constant used in artificial neural network to affect the speed of learning. Increasing it will make learning faster, in our case large changes wiil be made to weights to fit data. However, increasing it too much will result in weight bouncing around the error surface, decreasing productivity.

3. **What is batch size? Suppose the memory is unlimited, what is the most ideal batch size then? In that case, how many batches are taken per epoch?**

Batch size is the number of training examples per iteration. It has direct effect on the memory usage. If the memory is unlimited we are free to arbitrarily large batch size. In this case, we are tempted to say that the ideal batch size would be equal to the number of examples. However, the fact is that updating all the examples at once is not very efficient and will result in decreased accuracy. In my experiments, I found that changing batch size from 32 to 128 had a minor impact on accuracy. Even with unlimited memory ideal batch size would be an optimal between training speed and accuracy, which depends on the situation. For practical purposes batch size of 32 to 256 are used.

4. **How much is a feature map shrunk by a 2x2 max-pooling layer? The baseline network has 3 2x2 max-pooling layers, thus what is the size of the output feature map after the last max-pooling layer, if the input feature map is 48x48?**

Feature map is shrunk by a factor of 4 (2 x 2) after 2x2 maxpooling layer with stride 2. After 3 such maxpooling layers the feature map will shrink to 6 x 6. Because, 48 / (2 * 2 *2) = 6. However, in our actual model convolution will also reduce size. So, the feature map will shrink in this order 48 => 46 => 23 (maxpooling) => 21 => 10 (maxpooling) => 8 => 4 (maxpooling). So, the final feature map will be 4 x 4.

5. **What is a Dropout layer and why do we need it?**

Drop out as the names suggests drops out multiple units from the input. In other words, some network nodes are switched off, so they do not interact with the network. we need dropout layers to prevent overfitting. Dropout helps network generalize well.

References

1. Very Deep Convolutional Networks for Large-Scale Image Recognition - K. Simonyan, A. Zisserman
2. github.com/fchollet/keras
3. keras.io
4. github.com/fchollet/deep-learning-models/releases
5. https://deeplearning4j.org
6. wikipedia.org/wiki/Convolutional_neural_network