MSBD6000B Project 2   Chan Kin Ho 20411918

Preprocessing:

Histogram equalization is performed on each of the training, validation and testing images. It is a method to improve the contrast of the image using its histogram. By effectively spreading out the most frequent intensity values, areas of lower local contrast can gain a higher contrast. Since the images are colored, their color space should be first converted from RGB into one of the color spaces that separates intensity values from color components, such as YCbCr. After performing histogram equalization on the intensity plane Y, they are converted back to RGB.

Model Selection:

Multilayer convolutional neural network is chosen to fit the images. It is basically a neural network with successive convolution layer followed by a maximum pooling layer, with several fully connected layers at the end. The final layer of the network output logits of 5 corresponding to the 5 classes of flowers to be classified. A soft max function is applied to the logits to make it a probability measure sum to 1. The loss is calculated as the cross-entropy between the logits after soft max and the true one-hot label of the images.

The model is trained by stochastic gradient descent, in which at each epoch a mini batch of 100 training images are fed forward to calculate the gradients which are back propagated to update the weights of each layer. Adam optimizer is used instead of the classical stochastic gradient descent procedure. It is a more effective algorithm as it calculates an exponential moving average of the gradient and the squared gradient, and the parameters control the decay rates of these moving averages.

To select the hyperparameters of the network, such as the learning rate, depth and width of the network, sizes and strides of kernels, drop out ratio and etc., the accuracy of a validation set is monitored for every 20 iterations. If this accuracy attains a maximum, the model is saved. Early termination is implemented by introducing a patience variable. After every iteration, patience will increase by 1. If accuracy attains the maximum, patience is reset to 0. If patience exceeds 100, the training will stop.

The architecture of the network is as followings:
[224x224x3] INPUT
[56x56x96] CONV 1: 96 11x11 filters at stride 4, same padding
[28x28x96] MAX POOL 1: 2x2 filters at stride 2
[28x28x256] CONV 2: 64 5x5 filters at stride 1, same padding
[14x14x256] MAX POOL 2: 2x2 filters at stride 2
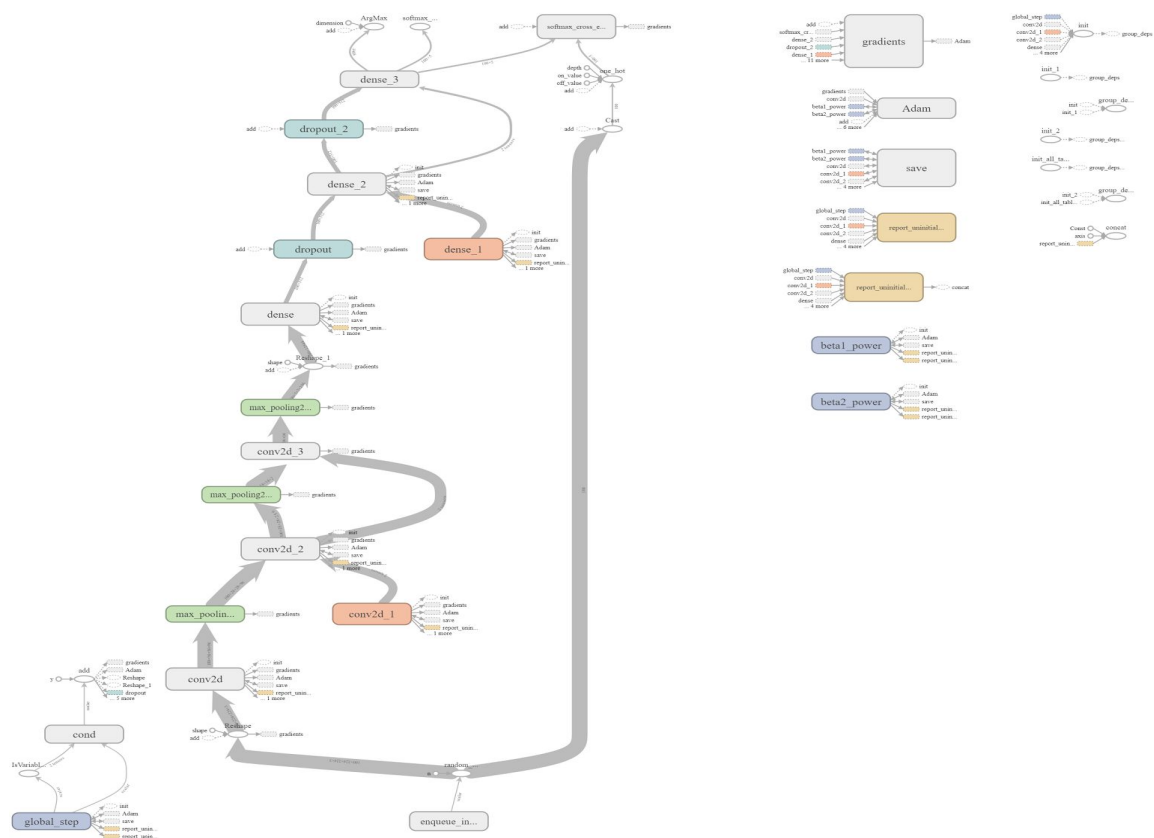[14x14x256] CONV 3: 64 5x5 filters at stride 1, same padding
[7x7x256] MAX POOL 3: 2x2 filters at stride 2
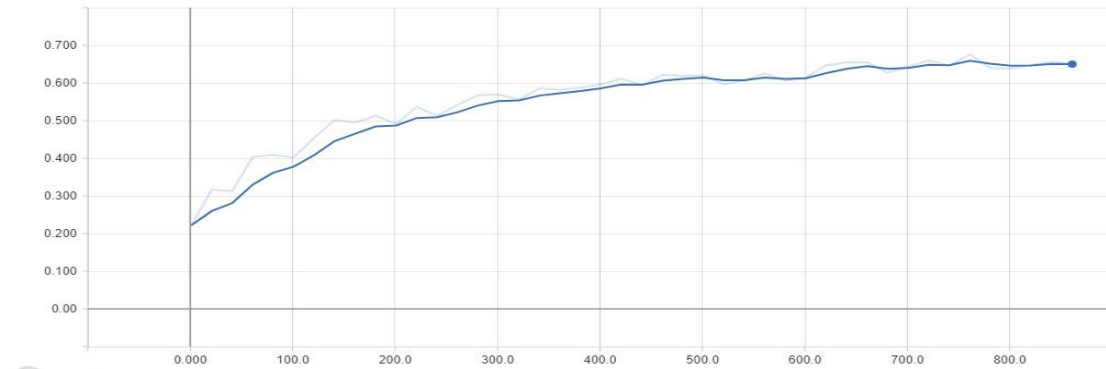[512] FC 4: 512 neurons
[512] FC 5: 512 neurons
[5] FC 6: 5 neurons (class scores)

Validation accuracy: 0.676364

ArgMax softmax_...

dimension
add

dense_3

add   softmax_cross_e...   gradients

depth
on_value   one_hot
off_value
add

dropout_2   gradients

add   Cast

dense_2   init
gradients
Adam
save
report_unin...
1 more

dropout   gradients   dense_1   init
gradients
Adam
save
report_unin...
1 more

dense   init
gradients
Adam
save
report_unin...
1 more

Reshape_1
shape   gradients
add

max_pooling2...   gradients

conv2d_3   gradients

max_pooling2...   gradients

conv2d_2   init
gradients
Adam
save
report_unin...
1 more

max_poolin...   gradients   conv2d_1   init
gradients
Adam
save
report_unin...
1 more

add   gradients
Adam
Reshape
Reshape_1
dropout
1 more

conv2d   init
gradients
Adam
save
report_unin...
1 more

cond   shape   Reshape   gradients
add

IxVariabl...

global_step   init
Adam
save
report_unin...
report_unin...

random

enqueue_in...

add
softmax_cr...
dense_2   gradients   Adam
dropout_2
dense_2
11 more

gradients
beta1_power   Adam
beta2_power
conv2d
conv2d_1
6 more

beta1_power   save
beta2_power
conv2d
conv2d_1
conv2d_2

global_step   report_uninitial...
conv2d
conv2d_1
conv2d_2
dropout
4 more

global_step   report_uninitial...   concat
conv2d
conv2d_2
conv2d_1
dense
4 more

beta1_power   init
Adam
save
report_unin...
report_unin...

beta2_power   init
Adam
save
report_unin...
report_unin...

global_step   init   group_depo
conv2d
conv2d_1
conv2d_2
4 more

init_1   group_deps...

init   group_de...
init_1

init_2   group_depo...

init_all_ta...

init_2   group_du...
init_all_tabl...

Const   concat
init
report_unin...

accuracy

0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.00

0.000   100.0   200.0   300.0   400.0   500.0   600.0   700.0   800.0

loss

1.80
1.60
1.40
1.20
1.00
0.800
0.600
0.400
0.200
0.00

0.000   100.0   200.0   300.0   400.0   500.0   600.0   700.0   800.0