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CSCE 636 – Deep Learning

Project Report

Proposed Method:

The method I used was a modified RESNET model, with the foundational ideas being similar to the ones from Homework 2. By default, batch normalization was used to train the data. Adam was used for the model optimizer. Additionally, I used cosine decay through a learning rate scheduler for Adam, and mix-up training to get better accuracy.

Implementation Details:

Software used:

1) Python 3.9
2) TensorFlow 2.7.0

The implementation began with the loading of image data and reshaping them accordingly in *DataLoader.Py*. They are then preprocessed through reshaping and normalization in *ImageUtils.py*. The model used has a modified resnet_layer and resnet_v1 model, derived from Keras. The model also utilizes mix-up training to better generalize the training data. For the optimizer, I tested Adam, Adagrad, and SGD. Adam turned out to be the fastest and most accurate (even though I personally expected SGD + momentum to do better). I used cosine learning rate decay to be used for the Optimizer. To improve performance, I was using *tensorflow.experimental.numpy* which is TensorFlow's implementation of NumPy. It can run all NumPy operations on GPU and improves by a speedup of 1.9x. Towards the end however, it was crashing, and therefore had to be removed.

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Testing Results:

Training Accuracy: 93% over 100 epochs

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Epoch 00090: accuracy did not improve from 0.92027
1612/1612 [==============================] - 51s 32ms/step - batch: 805.5000 - size: 31.9864 - loss: 0.4073 - accuracy: 0.9197 - lr: 5.8596e-04
Epoch 91/100
1611/1612 [============================>.] - ETA: 0s - batch: 805.0000 - size: 31.9863 - loss: 0.4036 - accuracy: 0.9224
Epoch 00091: accuracy improved from 0.92027 to 0.92242, saving model to ../trained_models\model.h5
1612/1612 [==============================] - 51s 32ms/step - batch: 805.5000 - size: 31.9864 - loss: 0.4035 - accuracy: 0.9224 - lr: 5.7822e-04
Epoch 92/100
1611/1612 [============================>.] - ETA: 0s - batch: 805.0000 - size: 31.9863 - loss: 0.4009 - accuracy: 0.9212
Epoch 00092: accuracy did not improve from 0.92242
1612/1612 [==============================] - 51s 32ms/step - batch: 805.5000 - size: 31.9864 - loss: 0.4008 - accuracy: 0.9212 - lr: 5.7045e-04
Epoch 93/100
1611/1612 [============================>.] - ETA: 0s - batch: 805.0000 - size: 31.9863 - loss: 0.3957 - accuracy: 0.9224
Epoch 00093: accuracy improved from 0.92242 to 0.92246, saving model to ../trained_models\model.h5
1612/1612 [==============================] - 52s 32ms/step - batch: 805.5000 - size: 31.9864 - loss: 0.3956 - accuracy: 0.9225 - lr: 5.6267e-04
Epoch 94/100
1611/1612 [============================>.] - ETA: 0s - batch: 805.0000 - size: 31.9863 - loss: 0.3931 - accuracy: 0.9226
Epoch 00094: accuracy improved from 0.92246 to 0.92260, saving model to ../trained_models\model.h5
1612/1612 [==============================] - 51s 32ms/step - batch: 805.5000 - size: 31.9864 - loss: 0.3931 - accuracy: 0.9226 - lr: 5.5487e-04
Epoch 95/100
1611/1612 [============================>.] - ETA: 0s - batch: 805.0000 - size: 31.9863 - loss: 0.3907 - accuracy: 0.9236
Epoch 00095: accuracy improved from 0.92260 to 0.92363, saving model to ../trained_models\model.h5
1612/1612 [==============================] - 51s 32ms/step - batch: 805.5000 - size: 31.9864 - loss: 0.3907 - accuracy: 0.9236 - lr: 5.4705e-04
Epoch 96/100
1611/1612 [============================>.] - ETA: 0s - batch: 805.0000 - size: 31.9863 - loss: 0.3841 - accuracy: 0.9262
Epoch 00096: accuracy improved from 0.92363 to 0.92617, saving model to ../trained_models\model.h5
1612/1612 [==============================] - 51s 32ms/step - batch: 805.5000 - size: 31.9864 - loss: 0.3841 - accuracy: 0.9262 - lr: 5.3923e-04
Epoch 97/100
1611/1612 [============================>.] - ETA: 0s - batch: 805.0000 - size: 31.9863 - loss: 0.3850 - accuracy: 0.9252
Epoch 00097: accuracy did not improve from 0.92617
1612/1612 [==============================] - 51s 32ms/step - batch: 805.5000 - size: 31.9864 - loss: 0.3850 - accuracy: 0.9252 - lr: 5.3140e-04
Epoch 98/100
1611/1612 [============================>.] - ETA: 0s - batch: 805.0000 - size: 31.9863 - loss: 0.3792 - accuracy: 0.9259
Epoch 00098: accuracy did not improve from 0.92617
1612/1612 [==============================] - 51s 32ms/step - batch: 805.5000 - size: 31.9864 - loss: 0.3792 - accuracy: 0.9259 - lr: 5.2355e-04
Epoch 99/100
1611/1612 [============================>.] - ETA: 0s - batch: 805.0000 - size: 31.9863 - loss: 0.3735 - accuracy: 0.9293
Epoch 00099: accuracy improved from 0.92617 to 0.92931, saving model to ../trained_models\model.h5
1612/1612 [==============================] - 51s 32ms/step - batch: 805.5000 - size: 31.9864 - loss: 0.3735 - accuracy: 0.9293 - lr: 5.1571e-04
Epoch 100/100
1611/1612 [============================>.] - ETA: 0s - batch: 805.0000 - size: 31.9863 - loss: 0.3745 - accuracy: 0.9283
Epoch 00100: accuracy did not improve from 0.92931
1612/1612 [==============================] - 51s 32ms/step - batch: 805.5000 - size: 31.9864 - loss: 0.3745 - accuracy: 0.9283 - lr: 5.0785e-04
```

Public Dataset Testing Accuracy: 84%

```
Validation (or) Testing...
Setting up the network...
Previous model found in 'trained_models' folder. Using that for training...
2021-11-18 16:04:52.439443: I tensorflow/core/common_runtime/gpu/gpu_device.cc:1733] Found device 0 with properties:
pciBusID: 0000:08:00.0 name: NVIDIA GeForce RTX 3080 computeCapability: 8.6
coreClock: 1.8GHz coreCount: 68 deviceMemorySize: 10.00GiB deviceMemoryBandwidth: 707.88GiB/s
2021-11-18 16:04:52.439562: I tensorflow/core/common_runtime/gpu/gpu_device.cc:1871] Adding visible gpu devices: 0
2021-11-18 16:04:52.440579: I tensorflow/core/common_runtime/gpu/gpu_device.cc:1258] Device interconnect StreamExecutor with strength 1 edge matrix:
2021-11-18 16:04:52.440919: I tensorflow/core/common_runtime/gpu/gpu_device.cc:1264]      0
2021-11-18 16:04:52.441269: I tensorflow/core/common_runtime/gpu/gpu_device.cc:1277] 0:   N
2021-11-18 16:04:52.441769: I tensorflow/core/common_runtime/gpu/gpu_device.cc:1418] Created TensorFlow device (/job:localhost/replica:0/task:0/device:GPU:0 with 7440 MB me
C:\Users\aarya\anaconda3\envs\tf\lib\site-packages\tensorflow\python\keras\engine\training.py:2426: UserWarning: `Model.state_updates` will be removed in a future version.
  warnings.warn('`Model.state_updates` will be removed in a future version. '
2021-11-18 16:04:53.833146: I tensorflow/stream_executor/platform/default/dso_loader.cc:53] Successfully opened dynamic library cudnn64_8.dll
2021-11-18 16:04:54.265828: I tensorflow/stream_executor/cuda/cuda_dnn.cc:359] Loaded cuDNN version 8201
2021-11-18 16:04:54.943836: E tensorflow/core/platform/windows/subprocess.cc:287] Call to CreateProcess failed. Error code: 2
2021-11-18 16:04:54.943925: W tensorflow/stream_executor/gpu/asm_compiler.cc:56] Couldn't invoke ptxas.exe --version
2021-11-18 16:04:54.947056: E tensorflow/core/platform/windows/subprocess.cc:287] Call to CreateProcess failed. Error code: 2
2021-11-18 16:04:54.947319: W tensorflow/stream_executor/gpu/redzone_allocator.cc:314] Internal: Failed to launch ptxas
Relying on driver to perform ptx compilation.
Modify $PATH to customize ptxas location.
This message will be only logged once.
2021-11-18 16:04:54.983176: I tensorflow/stream_executor/platform/default/dso_loader.cc:53] Successfully opened dynamic library cublas64_11.dll
2021-11-18 16:04:55.508816: I tensorflow/stream_executor/platform/default/dso_loader.cc:53] Successfully opened dynamic library cublasLt64_11.dll
2021-11-18 16:04:55.695339: I tensorflow/stream_executor/cuda/cuda_blas.cc:1838] TensorFloat-32 will be used for the matrix multiplication. This will only be logged once.
Test Loss:  0.70146861743927
Test Accuracy:  0.8435
```