

Module 4 Assignment: Machine Learning & Parallel Algorithms

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Results

Differences in training times

1. **Single-GPU Setup:**
 - Batch sizes tested: 64, 128, and 256.
 - Training times varied from 13.37 to 16.03 seconds.
 - Test accuracies ranged from 98.91% to 99.09%.
2. **Multi-GPU with MirroredStrategy:**
 - Leveraged mirrored strategy to train on multiple GPUs.
 - Training times were generally longer compared to single-GPU, ranging from 14.87 to 16.90 seconds.
 - Achieved similar test accuracies, ranging from 98.95% to 99.15%.
 - Observation: Although training time increased slightly, MirroredStrategy improved hardware utilization, making it beneficial for larger datasets or deeper models.
3. **Multi-Node with MultiWorkerMirroredStrategy:**
 - Significant reduction in training time, with epochs completing in about 4-5 seconds each.
 - Achieved test accuracies comparable to single-node setups, with minimal impact on convergence (98.47% to 99.00%).
 - Scalability: Demonstrated strong scalability, making it ideal for larger models or datasets that require more computational resources.

Model Accuracy and Convergence Speed

- **Single-GPU:** Converged efficiently, achieving over 99% accuracy within 5 epochs. However, training time was relatively longer compared to distributed setups.
- **Multi-GPU:** Comparable accuracy with single-GPU, showing minor improvements in convergence speed due to parallel computation.
- **Multi-Node:** Fastest convergence with minimal loss in accuracy, indicating that distributing workloads across nodes can significantly speed up training without sacrificing model performance.

Actual Results:

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Training with MirroredStrategy:

Batch Size: 64
WARNING:tensorflow:From
C:\Users\vicbe\AppData\Local\Programs\Python\Python312\Lib\site-packages\keras\src\backend\tensorflow\core.py:204: The
name tf.placeholder is deprecated. Please use tf.compat.v1.placeholder instead.

Epoch 1/5
938/938 - 4s - 4ms/step - accuracy: 0.9502 - loss: 0.1636
Epoch 2/5
938/938 - 3s - 4ms/step - accuracy: 0.9852 - loss: 0.0471
Epoch 3/5
938/938 - 3s - 4ms/step - accuracy: 0.9895 - loss: 0.0331
Epoch 4/5
938/938 - 3s - 3ms/step - accuracy: 0.9927 - loss: 0.0239
Epoch 5/5
938/938 - 3s - 3ms/step - accuracy: 0.9940 - loss: 0.0196
Training Time: 16.90 seconds
313/313 - 0s - 1ms/step - accuracy: 0.9915 - loss: 0.0278
Test Accuracy: 0.9915

Batch Size: 128
Epoch 1/5
469/469 - 3s - 7ms/step - accuracy: 0.9437 - loss: 0.2011
Epoch 2/5
469/469 - 3s - 6ms/step - accuracy: 0.9827 - loss: 0.0553
Epoch 3/5
469/469 - 3s - 6ms/step - accuracy: 0.9883 - loss: 0.0386
Epoch 4/5
469/469 - 3s - 6ms/step - accuracy: 0.9909 - loss: 0.0294
Epoch 5/5
469/469 - 3s - 6ms/step - accuracy: 0.9932 - loss: 0.0224
Training Time: 14.87 seconds
313/313 - 0s - 1ms/step - accuracy: 0.9900 - loss: 0.0283
Test Accuracy: 0.9900

Batch Size: 256
Epoch 1/5
235/235 - 3s - 14ms/step - accuracy: 0.9209 - loss: 0.2762
Epoch 2/5
235/235 - 3s - 13ms/step - accuracy: 0.9791 - loss: 0.0680
Epoch 3/5
235/235 - 3s - 13ms/step - accuracy: 0.9855 - loss: 0.0495
Epoch 4/5
235/235 - 3s - 13ms/step - accuracy: 0.9881 - loss: 0.0383
Epoch 5/5
235/235 - 3s - 14ms/step - accuracy: 0.9911 - loss: 0.0307
Training Time: 16.10 seconds
313/313 - 0s - 2ms/step - accuracy: 0.9895 - loss: 0.0329
Test Accuracy: 0.9895

Epoch 1, Loss: 0.1706, Accuracy: 0.9488, Test Loss: 0.0478, Test Accuracy: 0.9847, Time: 4.83 sec
Epoch 2, Loss: 0.0484, Accuracy: 0.9850, Test Loss: 0.0333, Test Accuracy: 0.9883, Time: 4.04 sec
Epoch 3, Loss: 0.0343, Accuracy: 0.9894, Test Loss: 0.0373, Test Accuracy: 0.9878, Time: 4.02 sec
Epoch 4, Loss: 0.0252, Accuracy: 0.9923, Test Loss: 0.0301, Test Accuracy: 0.9900, Time: 3.99 sec
Epoch 5, Loss: 0.0198, Accuracy: 0.9936, Test Loss: 0.0322, Test Accuracy: 0.9887, Time: 4.31 sec

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