

Handwritten Digits Recognition Implementing Backpropagation Neural Networks on CUDA

Xiaoyang Wang, Xueying Liao

Introduction

In this project we will implement the backpropagation algorithm for neural networks and apply it to the task of handwritten digit recognition. The backpropagation algorithm is an iterative process that starts from the last layer and moves backwards to the first layer. It calculates the change in the weights of each layer, which involves a large number of vector and matrix operations. Hence, we will implement CUDA, the high-speed parallel computational platform, to this algorithm to raise its operating speed.

Description

The program accepts matrixes that describe handwritten numbers as inputs and uses those matrixes to train the neural network. After enough training, the neural network should be able to make reliable recognition to the numbers. To discuss this in more detail, we will implement the backpropagation algorithm to compute the gradient for the neural network cost function, then minimize the cost function and learn a good set parameters.

Objective and Deliverables

We already have an implementation of a CPU version of this algorithm in Octave. We will use the parallel feature of CUDA to speed up the calculation like matrix/vector operations, cost function calculation, gradient calculation and parallel processing for each layer. The parallel feature we can utilize include coalesced access, tiling process, shared memory, parallel reduction and so on so forth. The feature of the computing in neural networks are highly matched to the parallel feature in cuda. By the end of this quarter, we will have a cuda accelerated neural network which can support reliable recognition to handwritten digits with lower time-consuming compared to the CPU version.

Background

We need a deep understanding of backpropagation algorithm and neural networks. One of our team member is very familiar with the mathematical calculation involved in the project. And we both have some relevant experiences in programming. In the next part, we list resources which can give both teammates a good mathematical basic.

Resources

We need a library contains enough matrixes of handwritten numbers.

- The MNIST database of handwritten digits, which has a training set of 60,000 examples, and a test set of 10,000 examples:

<http://yann.lecun.com/exdb/mnist/>

- Neural networks and deep learning-Chapter 2:

<http://neuralnetworksanddeeplearning.com/chap2.html>

- Backpropagation-Wikipedia:

<https://en.wikipedia.org/wiki/Backpropagation>

Contact Information

Xiaoyang Wang, xiaoyangwang2018@u.northwestern.edu

Xueying Liao, xueyingliao2018@u.northwestern.edu