CuCNN

CuML

CSN-221: Computer Architecture and Microprocessor

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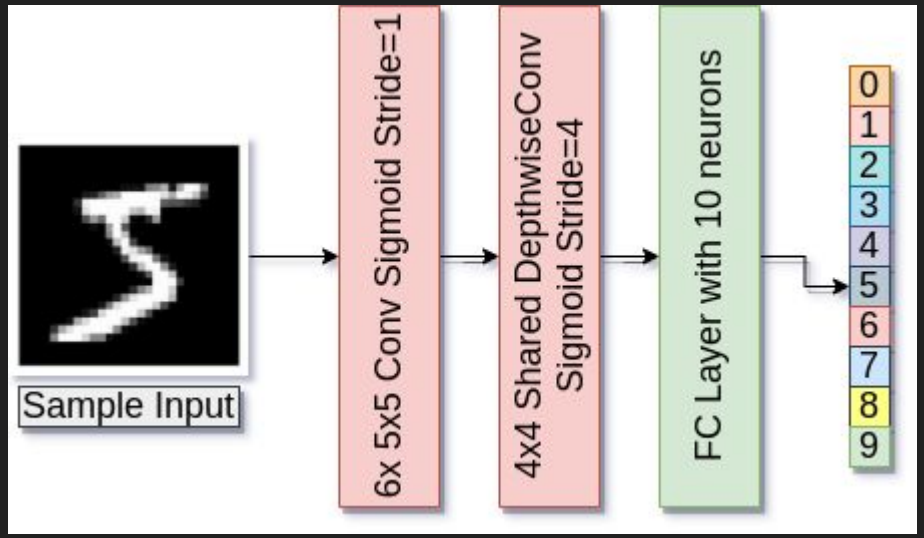
(Batch - O2)

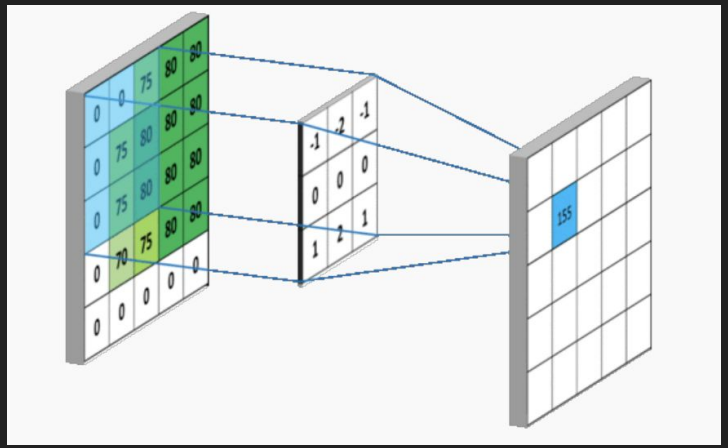
Contents

Project Statement

Implement a **3** layer **CNN** for Image Classification on MNIST using **CUDA** and observe the effect of different kernel settings on the performance of the model.



CNN Architecture

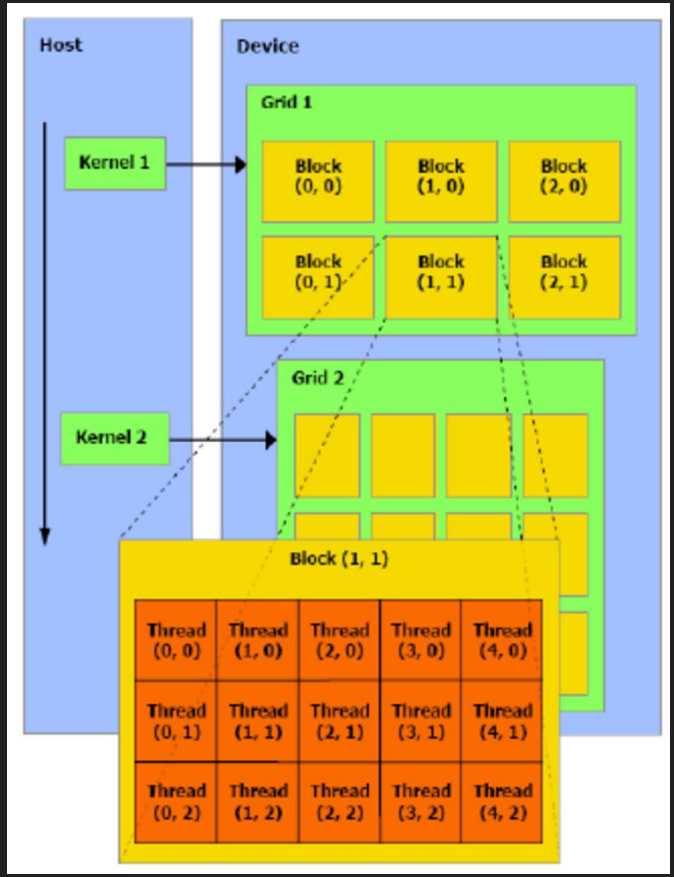


Convolution Operation [Source]

Setting

Show results on different settings of the kernel dimensions

- Host = CPU
- Device = GPU
- CNN has many operations like **convolution (sliding-window multiplications and additions), activation functions, backpropagation (gradient calculations),** etc.
- These all are executed using kernels which are composed of blocks (composed of threads).
- **kernel <<<NumBlocks, NumThreads>>>**



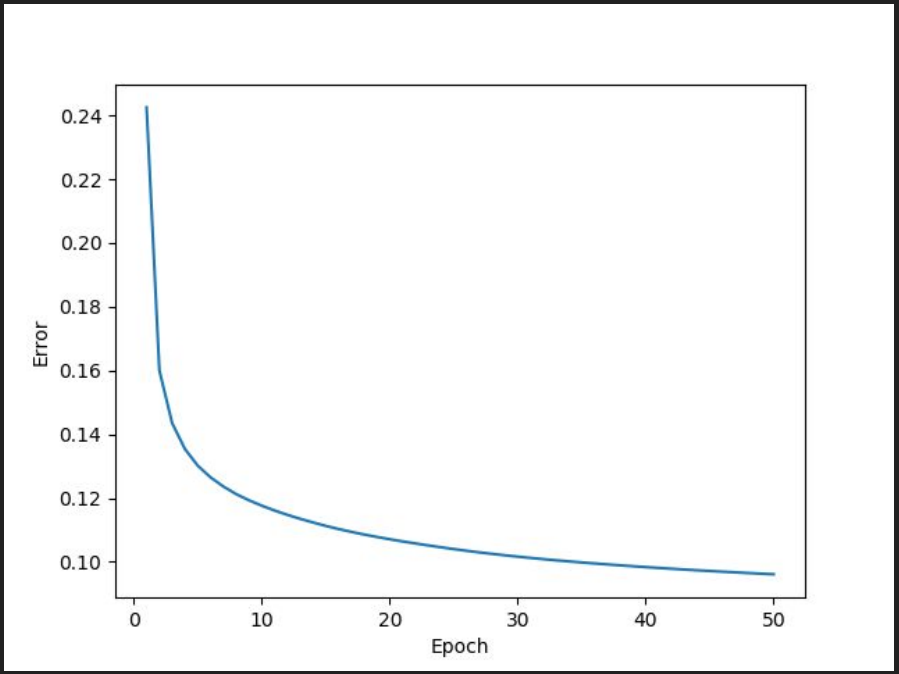
High-level Overview of CUDA [Source]

Observations

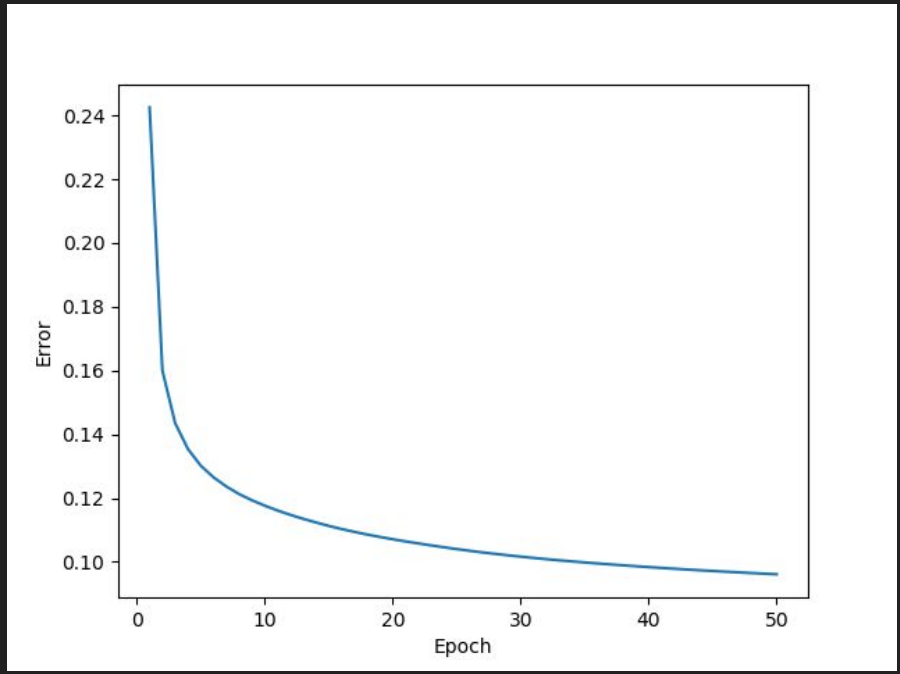
- Performance of the model depends on Grid Size (numBlocks) and Block Size (numThreads).
- Higher order (product) gives inaccurate results as compared to those of lower order *of 2*.
- As the order of the product becomes smaller, even if accuracy remains the same, training time increases (2^8 *order* v/s 2^{12} *order*).
- Products of the same order give almost the same results (in terms of time and accuracy).

Best Setting: kernel<<<64,64>

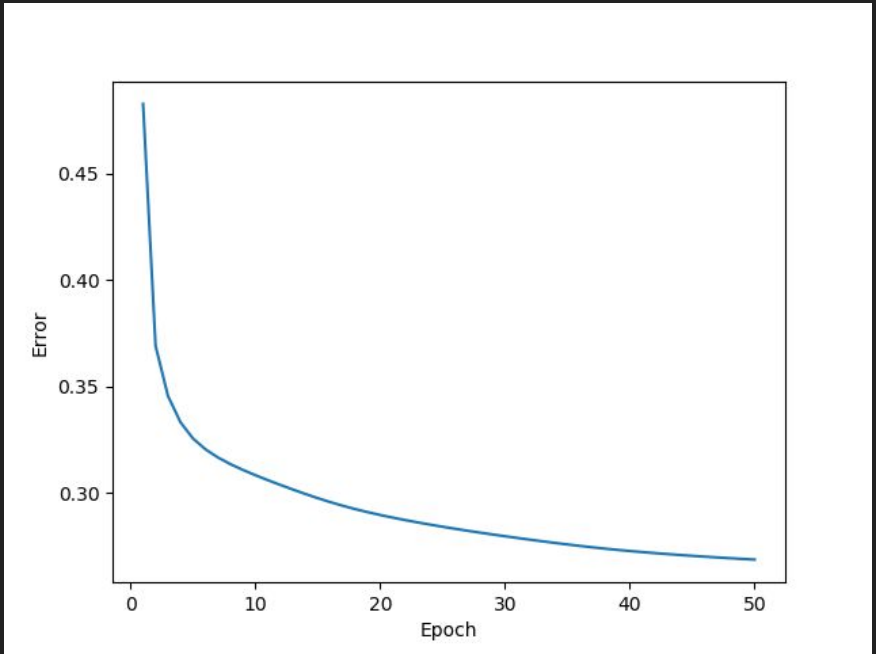
Grid Size	Block Size	Order (2)	Epochs	Test Accuracy	Training Time (Minutes)
64	**64**	**12**	**50**	**97.12**	**4.54**
64	64	12	100	**97.41**	9.10
128	512	16	50	87.92	4.86
256	256	16	50	87.92	4.93
16	16	8	50	97.12	10.02



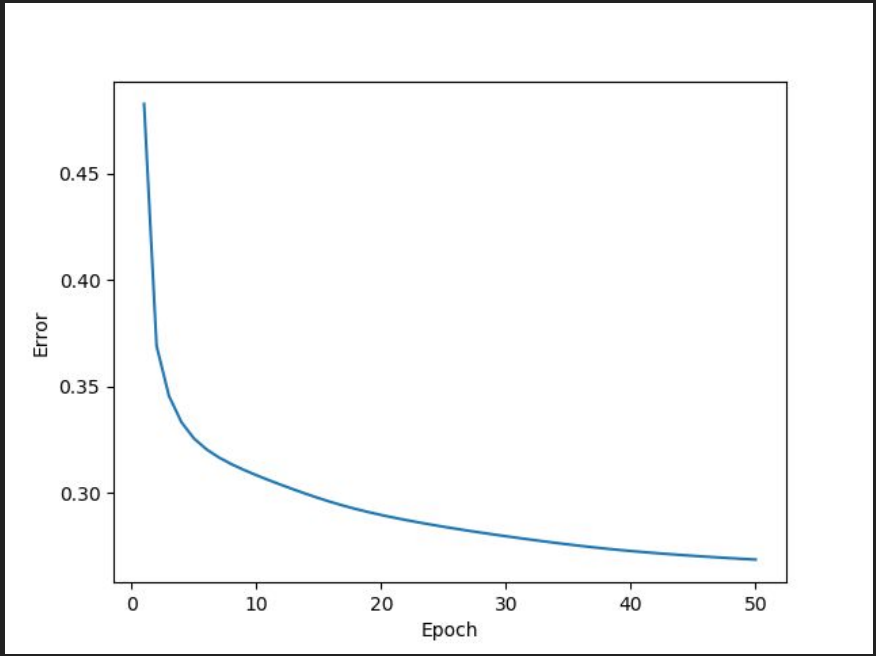
Epochs = 50
Order = 2^{12}
kernel<<<64,64>>>
Training Time = 4.54 minutes
Test Accuracy = 97.12%



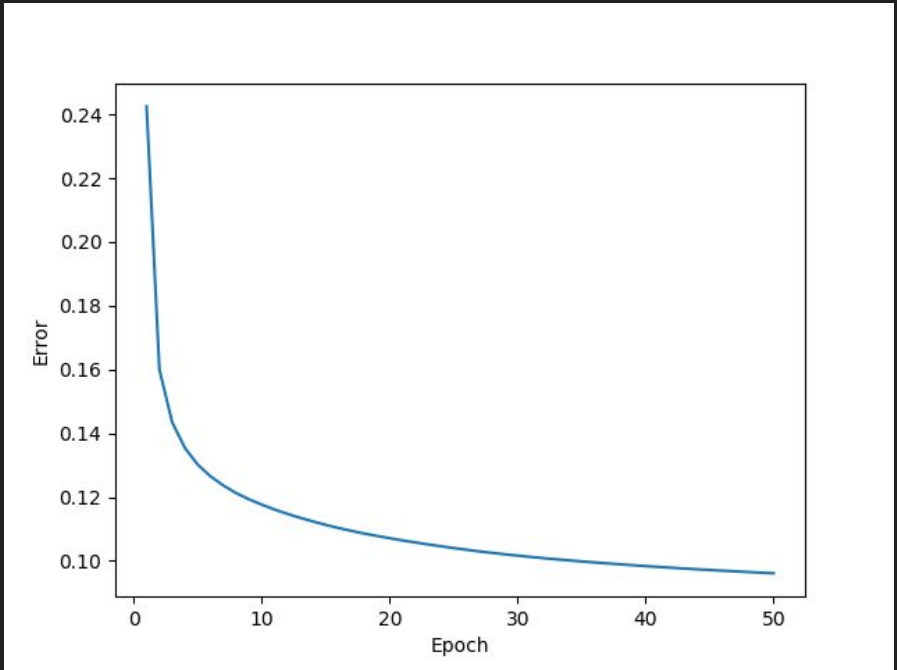
Epochs = 50
Order = 2^{8}
kernel<<<16,16>>>
Training Time = 10.02 minutes
Test Accuracy = 97.12%



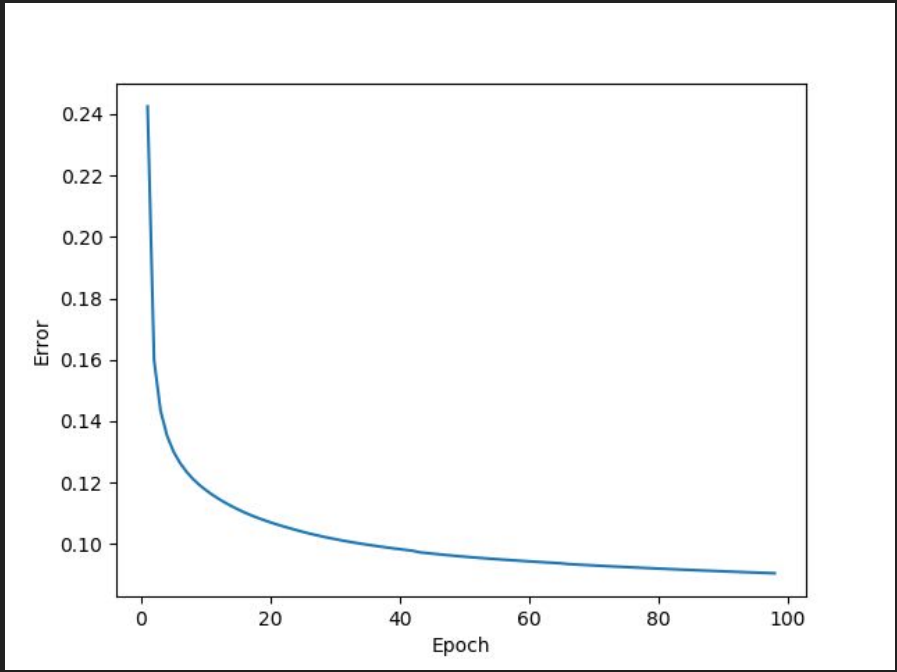
Epochs = 50
Order = 2^{16}
kernel<<<128,512>>>
Training Time = 4.86 minutes
Test Accuracy = 87.92%



Epochs = 50
Order = 2^{16}
kernel<<<256,256>>>
Training Time = 4.93 minutes
Test Accuracy = 87.92%



Epochs = 50
Order = 2^{12}
kernel<<<64,64>>>
Training Time = 4.54 minutes
Test Accuracy = 97.12%



Epochs = 100
Order = 2^{12}
kernel<<<64,64>>>
Training Time = 9.10 minutes
Test Accuracy = 97.41%

References

- https://www.nvidia.com/content/cudazone/download/Getting_Started_w_CUDA_Training_NVISION08.pdf
- https://classroom.udacity.com/courses/cs344 (Course on Udacity)
- https://towardsdatascience.com/an-introduction-to-convolutional-neural-networks-eb0b60b58fd7
- https://www.researchgate.net/publication/221053545_Solving_Classification_Problems_Using_Genetic_Programming_Algorithms_on_GPUs
- ImageNet Classification with Deep Convolutional Neural Networks

Thank You