GPU parallelization of "Modified Fuzzy hyper line segment neural network (MFHLSNN)" for pattern recognition

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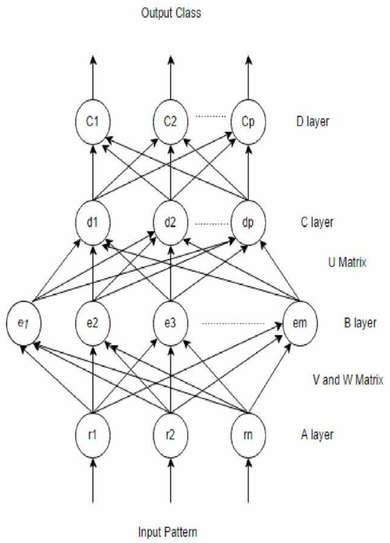
Abstract:- We propose a GPU parallelization of MFHLSNN [2], which is modification to [1]. It learns patterns in terms of hyper line segments (HLSs), which are fuzzy sets and are associated with fuzzy membership function. We achieved 2.5x, 10.75x and 10.71x speedup for training, classification and recognition phases, respectively, for this neural network, using NVIDIA's single Tesla K20 GPU for the skin data set [3], with 99.7% recognition.

MFHLSNN is a four layer neural network. First layer (A) simply accepts input patterns and forward it to next layer. Second layer (B) nodes represents HLSs and are created during training. Third layer (C) represents class nodes and gives soft decision. Fourth layer (D) gives hard decision. Weights between layers A and B are stored in matrices V and W. Matrix U is used to store weights on links connecting layer s B and C.



MFHLSNN Architecture

MFHLSNN training Algorithm

Input : Training set S with p patterns, $0 \le$ Threshold ≤ 1
Output : HLSs stored in matrices V and W.
begin :
Step 1 : Create HLSs
for i = 0 to row.
Find HLS of the class of i^{th} pattern. If no HLS are there,
then create a new HLS from i^{th} pattern., otherwise compute its
fuzzy membership in all HLS selected above.
if (membership > Threshold)
Check if i^{th} pattern falls on any HLS, then goto step1, otherwise extend
the HLS, giving maximum membership to.it and update V and W
else
Create a new HLS from i^{th} pattern and store it in V and W
end for
Step2 : Return V and W
end

GPU parallelization of MFHLSNN training

Computing membership of i th training pattern in all existing HLSs, is parallelized on GPU by launching k CUDA threads, if k HLSs are stored in V and W.

MFHLSNN Classification algorithm

Input : Training pattern set S with p patterns, Matrices V and W with r rows
Output : Count
begin :
count = 0;
Step 1 : for i = 0 to p
for j = 0 to r
Find fuzzy membership of i^{th} pattern in j^{th} HLS using V[j] and W[j].
end
Find Maximum membership of i^{th} pattern and index of that HLS, say k
Assign class of k^{th} HLS to pattern p. If p indeed belongs to that class then
count = count + 1;
end for
Step 2 : Return count
end

GPU parallelization of MFHLSNN Classification

Computing membership of i th training pattern in all r existing HLSs, is parallelized on GPU by launching r CUDA threads. We store ith pattern in GPU shared memory. The maximum fuzzy membership is computed using CUDA reduction kernel.

Data set used

We used skin segmentation data set from UCI repository [3]. It contains 245057 instances, 4 attributes and 2 classes. We used half instances for training and half for the testing phase.

Platform Used

CPU: Intel's Xeon(R) CPU E5-1620, 3.60 GHz, 16 GB RAM, windows 7, 64 bit OS, Release mode, x64 platform, Windows-7, VC++ on VS2010.
GPU: NVIDIA's Tesla k 20, CUDA toolkit- 5.5

Conclusion:-

We obtained 99.7% recognition for threshold 0.85, with 2.5x, 10.75x and 10.71x speedup for training, classification and recognition phases, respectively. We can expecting better speedup for larger data sets.

References

[1] U.V. Kulkami, T.R. Sontakke, and G.D. Rartdale, "Fuzzy hyperline segment neural network for rotation invariant handwritten character recognition", in proc. of IEEE's : Int. Conf. *IJCNN*, 2001.
[2] P.M Patil. P.S. Dhabe, U.V. Kulkani and T.R. Sontakke, " *Recognition of handwritten characters using modified fuzzy hyperline segment neural network* ", Int. Conf. *on fuzzy systems (FUZZ_IEEE 03),* May 2003.
[3] https://archive.ics.uci.edu/ml/datasets/Skin+Segmentation