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Parallel learning algorithms for large scale neural networks

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Abstract

Recently, many researchers pay much attention to neural networks as a new scheme of information processing without particular descriptions of relation between inputs and outputs. Since large neural networks require a huge learning times, high-speed learning algorithms have been expected for large scale problems. This paper addresses learning algorithms on parallel computers for the two typical neural networks; multilayer neural networks and Self Organizing Map(SOM). New learning schemes are proposed to compensate hardware defects of neural networks in VLSI.

For multilayer neural networks, many parallel back-propagation(BP) algorithms have been proposed, but most of them are suitable for specific parallel computers. BP algorithms are classified into three parallel models based on parallelism in BP, and fundamental properties of these parallel models are analyzed theoretically. By implementing these parallel learning algorithms on parallel computer nCUBE/2, parallel performances are discussed in detail. It is seen from theoretical analysis and experimental results that the learning-set parallel model performs the fastest learning time. Since hardware defects are inevitable for neural networks in VLSI implementation, a new learning scheme is proposed by compensating hardware defects. Most of algorithms to compensate defects, however, need some restrictions on learning sets or weights, and require a large amount of retraining time. To achieve faster defect-compensation, I propose the partial retraining scheme that retrain only neurons affected by hardware defects. By applying the partial retraining scheme to large neural networks, it is seen that the scheme achieves good learning performance.

Input layer dividing model(IDM) for parallel learning of SOM. We discuss forgetful learning algorithm to avoid dead nodes and compensate hardware defects. When competitive units are larger than input units, traditional competitive layer dividing model(CDM) can not achieve enough speedup by communication overhead between processing elements(PEs). It is seen by numerical simulations that IDM can generate good topographic maps and achieve faster learning speed than CDM by keeping good load balance

between PEs. SOM has another problem called as dead node problem. Because dead nodes are left behind while learning, dead nodes cause incorrect topographic mappings. To eliminate dead nodes automatically, forgetful learning schemes are applied to SOMs. It is seen by numerical simulations that forgetful learning scheme can generate correct topographic map. Forgetful learning schemes can be also applied to compensate hardware defects in SOMs and the performance is discussed by numerical simulations.

Key Words: multilayer neural network, SOM, parallel learning algorithms, high-speed learning, fault recovery