

A proposition of a parallel structure in two threads for neural network to achieve the purpose of Incremental Learning

(including a simple example using Markov random field to illustrate a GNN realized by a combination of CNN and RNN)

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Abstract:

A convolutional neural network (CNN) is a perceptron network with multilayers of processing, which consists of explicit input and output layers, as well as multiple hidden layers. The hidden layers of a CNN typically consist of convolutional layers, activation layer, pooling layers, and fully connected layers. Obviously, the multilayers in CNN are in a serial structure.

A recurrent neural network (RNN), unlike CNN, has its own internal state as the memory to work with the sequences of inputs. In comparison, RNN to CNN in neural network (NN) is as Infinite impulse response (IIR) to finite impulse response (FIR) in digital signal processing (DSP). Thus, RNN is in a serial structure due to its DSP nature.

In data science, a graph is a data structure consisting of two components, vertices and edges. graph neural network (GNN) is a type of neural network operating on the Graph structure. A typical application of GNN is vertices classification. Recently, GNN has been proposed to be implemented by CNN or RNN. Consequently, GNN is also in a serial structure.

In this talk, we proposed a parallel structure of neural network in two threads with cross interaction. As an application example, we realize the GNN by the combination of CNN and RNN. More clearly, the vertices and the edges of GNN are separated to be included in CNN and RNN threads with cooperation. An even further simple example is illustrated by our work on Markov random field (MRF) using a local Ising model with the corresponding pixel cliques and line cliques, which are realized respectively in the CNN and RNN threads.

It is noted that the edges in RNN determines the connection of the vertices in CNN. Thus, RNN provides the primary decisions and then controls the secondary decisions provided by CNN. Therefore, our proposed parallel structure for neural networks may help the applications for machine learning in Incremental Learning.

Key words:

Neural network, graph neural network, Markov random field