An Analytical Method for CNN Template Schema Discovery Using Dynamic Approach

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1 Introduction

Cellular Neural Network (CNN) is a novel information processing paradigm which was first proposed by Chua and Yang in 1988. The CNN is a combination of two powerful models of computation which are Hopfield Neural Network (HNN) and Cellular Automata (CA). Moreover, the CNN model has two important features: real time signal processing and local connection. From one point of view, the characteristic of real time processing has extensively exploited in various applications of parallel processing and real time image processing, connected component detection and morphological operations. On the other hand, the characteristic of local connection make it applicable to VLSI implementation and also allows high speed 1D and 2D signal processing including linear or nonlinear filtering, feature extraction and real time processing. The CNN model is a parallel paradigm of computation which depends on spatial arrangement of analogue non-linear processors known as cells. Each cell is connected to its neighbors, therefore only the adjacent cells can interact directly with each other. For a typical CNN array with M rows and N columns on a two dimensions , the dynamic state of each cell can be described by the following equation:

$$\dot{x}_{ij}(t) \ = -\dot{x}_{ij}(t) + \sum_{kl \in N_r(i,j)} A\,(i,j;\ k,l) y_{kl}\,(t) + \sum_{kl \in N_r(i,j)} B\,(i,j;\ k,l) u_{kl}\,(t) + I_{ij} \tag{1}$$

The most important issue of designing CNN is finding the satisfactory values of the feedback template "A", control template "B" and the bias "I". Designing effective robust template depends on the sphere of influence r, the sphere of influence determines the effective window size of cells that belongs to specific cell C_{ij}.

2 Problem Statement

The most important key point of CNNs application is how to find the optimal template schema to achieve CNN stability. In recent years, the problem of CNN design for image processing, has attracted considerable attention and the

promising potential of CNN has resulted in the development of several templates design methods. Researches proposed various studies to determine the optimal values of the template values such as analytical, evolutionary and hybrid approaches. From a particular point of view, the cells which belongs to r which represents the radius of the sphere of influence $C(i,j)$ are arranged in matrix of $(2r+1),(2r+1)$ grid whose center cell is $C(i,j)$. In order to design optimal and robust CNN template a careful feature selection approach is required. Rough Set theory is used to select a subset of features that is most suitable for a given problem.The generated subset of attributes is called reduct, many researches proposed various reduction algorithms and techniques. However, most of these algorithms can only applied to static data sets. Classic Attribute Reduction could be applied to CNN template design as shown by many researches, but it is time consuming approach to recompute the reduction algorithm every time an object changes.

This paper focus on attribute reduction of dynamical data sets based on information entropy measure among cells. Information entropy is a significant measure of uncertainty for a given data set, which have been widely applied to devise heuristic attribute reduction algorithms. The main idea of the proposed algorithm is to find the change of entropy that occurred due to the change of some data values. When a part of data is changed by some new values, the proposed algorithm should find the new reduct directly instead of repeating the computing over the whole decision table.

3 Methodologies

List of Equations

$$S_r(i,j) = \{C_{k,l} := max(\mathsf{k\text{-}i}, \mathsf{l\text{-}j}) \leq r;\ 1 \leq k \leq M, 1 \leq l \leq N\} \tag{2}$$

$$U_{x'}/C = \left\{X_1, X_2, .., X_{p1}^{'}, .., X_{p2}^{'}, ..., X_m\right\} \tag{3}$$