Building and Evaluation of a Distributed Neural Classifier

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Abstract

This article describes an automatic method for building of distributed neural classifiers for pattern recognition. The methodology is based upon the detection of reliable regions in the representation space, i.e. clusters exclusively composed of patterns from the same class. This detection is performed using a hierarchical clustering method associated with the supervised information provided by a professor. The proposed methodology consists of associating each of these regions with a Multi-Layer Perceptron (MLP) which has to recognise elements inside its region, while rejecting all others. Experimental results for a real problem (handwritten digit recognition) reveal an interesting generalisation behaviour of the distributed classifier in comparison to the k-nearest neighbour algorithm as well as a single MLP.

1. Introduction

Neural networks, and more particularly Multi-Layer Perceptrons (MLP) [1] have received a great deal of attention in recent years in the field of pattern recognition. Reasons of this success essentially come from their universal approximation property [2] and, above all, their good generalisation capabilities. However, obtaining good generalisation behaviour is not a trivial task when dealing with complex problems, since a suitable neural network architecture has to be determined. Since there is no reliable and generic network building rule currently available [3-6], finding an efficient architecture can require a large amount of trial and error that must be carried out by a specialist.

The approach proposed in this paper redefines the learning task of a neural network so that a simple network building rule can lead to good generalisation capabilities, while avoiding human assistance. This redefinition follows a "divide and conquer" strategy. The objective is to split a classification problem into several simpler ones. The method investigated in the next section achieves this objective while ensuring a coherency with the data distribution. Section 3 shows experimental results for a handwritten digit recognition problem.

2. Distributing the classification problem

Distributing a classification problem presents two main points of interest. The first one is to give the opportunity to simplify the design and the training of a neural network by dividing up a given task into several simpler ones. The second advantage (which will not be developed in this paper) is to engineer a modular classifier. This feature implies an easy-to-update system : it will be possible to keep a part of the classifier after an adding of data in the training database.

The simplest problem to be given to a neural network is probably a linearly separable one. Unfortunately, few real problems present this feature. A second class of simple classification problems - although more complex than the previous one - may be encountered for a two class problem such that at least one of them is constituted by a unique pure cluster (i.e. containing elements of the same class only). The proposed divide and conquer strategy aims to identify this kind of cluster - called an « islet » - in order to provide as many tasks as islets. If N islets are detected, the classifier will thus be constituted from N neural networks, each of them being quite simple to configure and being expected to present good decision boundaries.

To achieve this, the first stage consists of capturing the structure of the data in the representation space. That is to say one determines the number and the constitution of the clusters in it. The problem of distributing a classification task is thus converted into a clustering one. The most commonly used techniques are certainly partitional ones (like k-means [7]) and Self-Organising Maps [8]. The main