

INDUCING COMPACT NNTREES THROUGH DISCRIMINANT MULTIPLE CENTROID BASED DIMENSIONALITY REDUCTION

HIROTOMO HAYASHI AND QIANGFU ZHAO

Graduate Department of Computer and Information Systems
The University of Aizu
Tsuruga, Ikki-machi, Aizu-Wakamatsu, Fukushima 965-8580, Japan
{ d8092103; qf-zhao }@u-aizu.ac.jp

Received February 2010; revised June 2010

ABSTRACT. *Neural network tree (NNTree) is a hybrid model for machine learning. Experimental results have shown that, compared with fully connected neural networks (NNs), NNTrees are more suitable for structural learning; and compared with standard decision trees (DTs), NNTrees are more accurate. To reduce the implementation cost of the NNTrees, we have tried to induce compact NNTrees through dimensionality reduction. We have first studied the linear discriminant analysis (LDA) approach and found that LDA can reduce the implementation cost greatly without degrading the system performance significantly in most cases. However, when the number N_t of data is large and the dimensionality N_d of the feature space is high, using LDA can be computationally very expensive. One method for solving this problem is to use the direct centroid (DC) approach. Unfortunately, through experiments we found that features extracted by DC are not informative enough for obtaining good NNTrees. In this paper, we propose the discriminant multiple centroid (DMC) approach. In DMC, all data are first mapped to a lower dimensional space based on the centroids, and LDA is then conducted in the mapped space. Experimental results with several public databases show that DMC is as effective as LDA, however, is more efficient when both N_t and N_d are large.*

Keywords: Machine learning, Pattern recognition, Neural network, Multivariate decision tree, Dimensionality reduction

1. Introduction. With the rapid progress in computing technology, more and more portable systems are available in the marketplace, and different new services are provided by these systems. Digital cameras, cell phones, e-books and IC cards are well-known examples of portable systems. One common characteristic of these portable systems is that they often contain a large number of important personal data, including photographs, purchased contents, personal mails, banking records, and so on. In other words, each portable system is now becoming a mobile database which can provide different kinds of information to the user whenever necessary. From the point of view of information security, carrying the personal database is safer than storing it to some remote server and accessing the data through public network. The point is, when the personal database becomes larger and larger, how can the user access the needed information efficiently? To answer this question, it is necessary for the portable system to have some kind of learning ability so that the database can be represented, stored, updated and accessed efficiently and effectively.

The goal of this study is to propose a good “machine learner” suitable for portable systems. To achieve this goal, we may use a neural network (NN) or a decision tree (DT). NNs are a class of learning models analogous to the human brain, and have been applied successfully to many fields, such as object detection, image recognition, speech recognition,