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A linear model based on Kalman filter for improving neural network classification performance

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ABSTRACT

Neural network has been applied in several classification problems such as in medical diagnosis, handwriting recognition, and product inspection, with a good classification performance. The performance of a neural network is characterized by the neural network's structure, transfer function, and learning algorithm. However, a neural network classifier tends to be weak if it uses an inappropriate structure. The neural network's structure depends on the complexity of the relationship between the input and the output. There are no exact rules that can be used to determine the neural network's structure. Therefore, studies in improving neural network classification performance without changing the neural network's structure is a challenging issue. This paper proposes a method to improve neural network classification performance by constructing a linear model based on the Kalman filter as a post processing. The linear model transforms the predicted output of the neural network to a value close to the desired output by using the linear combination of the object features and the predicted output. This simple transformation will reduce the error of neural network and improve classification performance. The Kalman filter iteration is used to estimate the parameters of the linear model. Five datasets from various domains with various characteristics, such as attribute types, the number of attributes, the number of samples, and the number of classes, were used for empirical validation. The validation results show that the linear model based on the Kalman filter can improve the performance of the original neural network.

1. Introduction

The classification problem is the problem of assigning an object into one of predefined classes based on a number of features or attributes extracted from the object (Zhang, 2000). In machine learning, classification is categorized as a supervised learning method. A classifier is constructed based on a training set with known class labels (Alpaydin, 2010). Classification problems occur in various real world problems, including problems in character recognition (Gao & Liu, 2008), face recognition (Zhifeng, Dahua, & Xiaoou, 2009), speech recognition (Chandaka, Chatterjee, & Munshi, 2009), biometrics (Lyle, Miller, Pundlik, & Woodard, 2012), medical diagnosis (Akay, 2009; Mazurowski et al., 2008; Verma & Zhang, 2007), industry (Jamil, Mohamed, & Abdullah, 2009; Kılıç, Boyacı, Köksel, & Küsmenoğlu, 2007; Nashat, Abdullah, & Abdullah, 2014; Rocha, Hauagge, Wainer, & Goldenstein, 2010), business (Chen & Huang, 2003; Huang, Chen, & Wang, 2007; Min & Lee, 2005), and science (Evett & Spiehler, 1987; Sigillito, Wing, Hutton, & Baker., 1989). Several classification algorithms have been proposed to solve classification problems, namely decision tree (Quinlan, 1986), linear discriminant analysis (Li & Yuan, 2005), Bayesian classifier (Domingos & Pazzani, 1997), rule-based classifier (Clark & Niblett, 1989), neural network (Lippmann, 1987), *k*-nearest neighbor (Cover & Hart, 1967), and support vector machine (Cortes & Vapnik, 1995).

Artificial neural network or simply neural network is a computational model inspired by the biological nervous system. Neural network is a nonlinear model, which is very simple in computation and has the capability to solve complex real problems including prediction and classification. Neural network has appears to be a significant classification method and an alternative to

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