Learning Ability Evaluation based on Machines Learning Method

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Abstract

Aiming at the problem of incomplete and subjective evaluation of college students learning ability, an evaluation method based on machine learn theory is put forward. Firstly, the deep belief network is used to extract the effective information from the original index characteristics, which greatly reduces the correlation between the indexes. Then, the support vector machine model is used to realize the automatic evaluation of college student learning ability, which is suitable for small sample and nonlinear classification problems. Experimental results show that compared with other evaluation methods, the proposed method has better generalization performance, and can obviously improve the evaluation effect of college student learning ability.

Keywords

Learning ability evaluation, deep learning method, feature learning, support vector machine, depth belief network.

1. Introduction

The learning ability evaluation of college student is a hot issue, and it is also an important part of the educational reform at the present stage. Many scholars have pay attention to this problem [1]. With the arrival of the information age, society demands more and more talents, and how to learn to study and improve their quality and ability continuously should be a key issue for college students. So the cultivation of students learning ability is a basic requirement for higher education. It is urgent to reasonable evaluate the student learning ability, and to continue improve their learning ability on this basis [2].

At present, the thought of some university student is not very mature, and couple with the lack of positive guidance and encouragement. They are no clear learning objectives, learning interest and learning motivation, no reasonable planning for future life [3]. In order to solve the above problems, many scholars have studied the essence, mechanism and influence factors of self-regulated learning, and made great progress on these issues [4]. Some experts proposed that the learning ability evaluation should give full consideration to student cognition, motivation and behaviour, and proposed that we should collect the comprehensive information with the scientific development perspective, and should accurate evaluate the learning ability to meet the principle of objectivity without personal feelings [5].

In this paper, we propose a new learning ability evaluation method for college student. First, we use a deep belief network to extract the effective feature of learning ability for college student, which greatly reduces the correlation between the indexes. Next, we use support vector machine classifier to classify the student learning ability as qualified or unqualified. Experimental results show that compared with other evaluation methods, this method has better generalization performance, and can obviously improve the evaluation effect.

2. Evaluation feature extraction

Deep learning is a new method of machine learning, which can learn and mine complex, nonlinear feature representation from unlabeled data with various network models [6-7]. It has been successfully used in image process and pattern recognition field [8]. The deep belief network (DBN) is a class deep learning model, which has excellent ability in feature extraction. The deep belief network is composed of some restricted Boltzmann machine (RBM) networks, which is trained using an unsupervised learning strategy [9]. In this paper, we use the strong learning ability of deep confidence network to extract the effective feature of learning ability for college student.

2.1 Restricted Boltzmann Machine

Restricted Boltzmann machine is an energy model, which consists of visible layer and hidden layer. Each visible layer and hidden layer is connected with the neurons, while the neurons in the same layer are not connected [10]. Fig. 1 is a typical restricted Boltzmann machines structure, in which parameter v, h and w represents the connection weights between the visible layer, the hidden layer, and the visible layer and the hidden layer respectively.

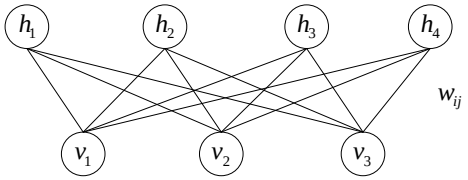

Fig. 1 Restricted Boltzmann Machines

The restricted Boltzmann machine is a kind of stochastic neural network, whose visible layer and hidden layer neuron are random variables between 0 and 1. Suppose N and M is the number of neurons in the visible layer and the hidden layer, respectively. v_i and h_j represents the state of the i visible neuron and the j hidden neuron respectively.

The energy function of the restricted Boltzmann machine is

$$E(V,h|\theta) = -\sum_{i=1}^{N} a_i v_i - \sum_{j=1}^{M} b_j h_j - \sum_{i=1}^{N}\sum_{j=1}^{M} w_{ij} v_i h_j \ . \tag{1}$$

in which $\theta = (w_{ij}, a_i, b_j)$ is the parameter vector to be determined by the restricted Boltzmann machine, where w_{ij} represents the connection weights between the visible layer neurons and the hidden layer neurons, a_i and b_j is the bias values of v_i and h_j respectively.

The state of the restricted Boltzmann machine satisfies the normal distribution, and the joint probability distribution in the state (v,h) can be expressed as:

$$p(v,h|\theta) = \frac{e^{-E(v,h|\theta)}}{\sum_{v}\sum_{h}} e^{-E(v,h|\theta)} \ . \tag{2}$$

Neurons of the same layer in the restricted Boltzmann Machine are not direct connected, so the conditional probability distribution $p(v,h|\theta)$ of each neuron can be written as:

$$p(h_j = 1|v,\theta) = \sigma(b_j + \sum_{i=1}^{I} v_i w_{ij}) \ . \tag{3}$$

$$p(v_i = 1|h,\theta) = \sigma(a_j + \sum_{j=1}^{J} h_i w_{ij}) \ . \tag{4}$$

where $\sigma(x) = 1/(1+e^{-x})$ is the Sigmoid function.

The parameter vectors θ of the restricted Boltzmann Machine can be determined by finding the following maximum log likelihood functions.

$$\theta = \arg\max_{\theta} L(\theta) = \arg\max_{\theta} \sum_{t=1}^{L} \ln p(v^{(t)} | \theta)) . \quad (5)$$

where L is the number of samples. by using iterative learning strategy, we can obtain the update rules of each parameter θ as paper [11].

2.2 Efficient Feature Extraction

The deep belief network is a network model composed of multilayer restricted Boltzmann machine, in which the output of the underlying restricted Boltzmann machine is used as the input of the upper bound Boltzmann machine [12]. The deep belief network simulates the structure of human brain for hierarchical processing of information. From low level to advance level by layer to extract the input data features, we can eventually get more objective and essential feature vector on the top layer.

In this paper, the input being provided to the first layer, and the output provided to the output of the next layer. The connections of DBN are determined via the top-down generated weights, and the parameters of each layer are learned with iterative learning method. The outputs of the hidden layer are considered as the extracted features. The steps to extract efficient learning ability evaluation features using deep belief network are as follows:

1) We construct the evaluation index system of college student learning ability, and set up a feature vector.

2) For the first layer of restricted Boltzmann machine, we use an unsupervised training to obtain the estimation of the parameters where the index vectors are as the inputs of restricted Boltzmann machine.

3) For the other layers of RBM, the underlying output of RBM as a restricted Boltzmann machine input, we use an unsupervised training to obtain the network parameter estimation.

4) We use a supervised training method to tune the parameters of each layer until the deep belief network reaches a global optimization.

5) We extract the feature vectors of the test samples with the trained the deep belief network, in which the evaluation indexes are used as inputs to the deep belief network.

3. Learning Ability Evaluation

In this section, we regard as the evaluation of college student learning ability as a classification problem in essence. The support vector machines (SVM) is a classical pattern classification method, which is based on the VC theory and structural risk minimization principle [13].

The core idea of support vector machines is to establish an optimal classification surface as a decision function, which can divide the known samples into two categories, and meanwhile satisfies the largest constraint condition of the classification interval. The support vector machines do not require a higher number of known samples than the neural networks, and the classification process is a convex optimization problem, which is suitable for small sample and nonlinear classification problems.

Given an independent distribution of the college student set $X = \{(x_i, y_i), i = 1,2,..,n\}$, $x_i \in R^d$ .The classification problem can briefly describe as follows: if the student sample x_i is of the qualified type, y_i is marked as positive, and if the student sample x_i belongs to an unqualified type, y_i is marked as negative. For the corresponding nonlinear classification, we can project the original space to a high dimensional Hilbert space via a nonlinear kernel function. In Hilbert space we can construct an optimal hyper plane to convert the nonlinear classification problem into a linear classification problem. Detailed description about the support vector machines theory can be finding in papers [14].

The classification function of college student learning ability can be expressed as:

$$f(x) = \mathrm{si}\, gn\left[\sum_{i=1}^{n} a_i y_i k(x_i, x) + b\right]. \quad (6)$$

where kernel function $k(x_i, x) = \exp\left(-\|x - x_i\|^2 / 2\sigma^2\right)$.

4. Experimental results and analysis

In this section we present experimental results to validate the general approach. First, we collect the information from different students in diverse conditions and divide into train and test samples. Then we use the deep belief network to obtain efficient features. Lastly, we use support vector machines classifier to divide the students into qualified and unqualified. In this paper, the learning ability of college student includes such as Learning motivation, learning method, self adjustment, creative consciousness module etc. This learning ability evaluation module will be refined into learning attitude, student satisfaction, discipline construction, student awards, team help, and emotion recovery so on. In order to verify the effectiveness of the proposed method, we use the deep belief network and principal component analysis (PCA) method to extract the essential feature information from the evaluation information. When the number of neurons of the visible layer and the hidden layer is different, there are different recognition results. We find that the layer number is 3, and the node of the hidden layer is 8, the deep belief network has the best effect. For PCA method, we persist cumulative contribution of variance exceeds 85%. The evaluation results are shown in figure 2.

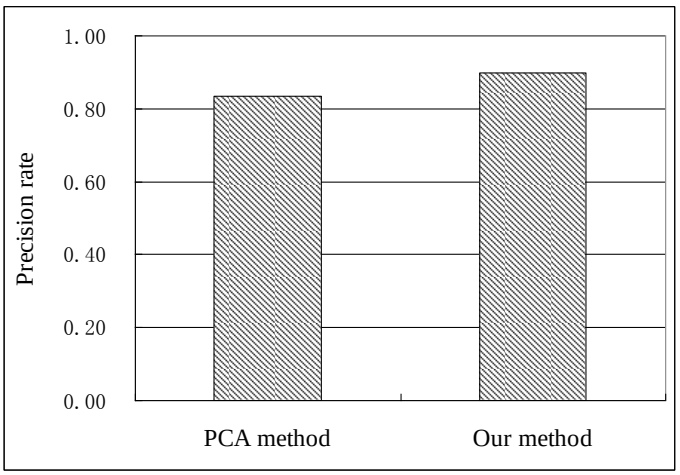

Fig. 2 The evaluation results

From Fig. 2 we can find that the above methods can evaluate not only the qualified but also unqualified very well, but the proposed method achieves more desired performance than other two methods. The evaluate precision of the proposed method is up to 90%, which is higher to the other method. These results demonstrate that the proposed is a good choose for learning ability evaluation, which is because that the deep learning method is based on neural networks to build models. The PCA method is a statistical method, which transforms the raw data into a set of linearly independent representations, which is not suit the nonlinear environment of learning ability evaluation. For simulating human brain analysis and learning with the hierarchical training strategy, the deep belief network has better feature extraction result than the PCA method. For the application of the proposed model, if the evaluation result is different from the actual situation, the sample can be added into the training set, and then the parameters can be adjusted again until satisfactory results are obtained.

5. Conclusion

This paper proposes a method for learning ability evaluation based on machine learning theory. We extract the essential feature information from the index system of college students by multilayer deep belief network, and evaluate the ability with support vector machines. We use the network to simulate the human thing process, as from simple to complex, from low to high layer to get the feature vector, which can learn excellent features for better representation of raw data. The next step is to do empirical analyze, improve the proposed method, and finally use for the evaluation of the learning ability for college student.

Acknowledgments

This work was supported by the Teaching Reform Research Foundation of Hunan Province Ordinary College under Grant No.[2016]400-934, the Hunan Provincial Social Science Achievement Review Committee Foundation under Grant No.XSPYBZZ005, Hunan Provincial Natural Science Foundation of China No. 2017JJ2015, the Hunan Province Social Science Foundation under Grant No.16YBA049, the Scientific Research Fund of Hunan Provincial Education Department under Grant No.15B040, the Teaching Reform Research Foundation of Hunan University of Finance and Economics under Grant No.2015yjjg02, and Hunan Province Education Scientific Planning Project No. XJK015BGD007.

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