Research on Early Academic Warning by a Hybrid Methodology

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ABSTRACT

Early academic warning is considered as an inherent problem in education data mining. Early and timely concern and guidance can save a student's university career. It is widely assumed as a multi-class classification system in view of machine learning. Therefore, An accurate and precise methodical solution is a complicated task to accomplish. For this issue, we present a hybrid model employing rough set theory with a back-propagation neural network to ameliorate the predictive capability of the system with an illustrative example. The experimental results show that it is an effective early academic warning model with an escalating improvement in predictive accuracy.

Key words

rough set theory, neural network, hybrid architecture, academic warning

Ⅰ. Introduction

As Chinese universities continue to expand their enrollment in recent years, the number of students has increased. It is difficult for universities to keep track of every student's learning status, which affects the quality of teaching to a certain extent. On the other hand, students encounter a new way of life after entering university. However, they are not good at learning independently or cannot adapt to the pressure of heavy coursework. Some fail exams, repeat grades, or drop out, which seriously affects their future careers. Early academic warning systems that automatically predict future learning performances are essential for students at risk of failing or repeating a course, or dropping out of university. Teachers can take action based on the prediction results, for example, by giving extra concern and guidance to at-risk students so that they can avoid academic failure. Therefore, the study of student performance prediction has become one of the most crucial research branches in education data mining.

Existing works are focused on score prediction and course recommendation [1][2]. In this work, we focus on the outcome of undergraduate study at the university: the possibility of achieving a bachelor's degree. Intuitively, students who do not perform well in their first year are at risk of not finishing with a degree. Therefore, early concern and guidance for these students from an academic risk early warning system are necessary. To this issue, a hybrid model employing Rough Set Theory (RST) with a back-propagation neural network [3] is used to estimate the risk of academic failure.

The RST is to derive decisions by attribute reduction while keeping the classification ability unchanged. The reduced attributes are fed into a back-propagation neural network for classification. Experimental results on the historical score dataset demonstrate the effectiveness of the proposed method in this paper.

Ⅱ. Experiment

In this work, the examination results of students enrolled in the Department of Computer Science of Hebei GEO University in 2016 and 2017 are used as the dataset. The data of the class of 2016 are used as the training set, and the data of the class of 2017 are used as the test set. The experiment is divided into three steps:

Step 1. Data preprocessing

The first step seeks to refine the irrelevant and redundant elements from the data. We converted students' first-year required course scores from a hundred-mark system to four grades, expressed as integers 1, 2, 3, and 4, as condition attributes of the decision table. The status of whether a student

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receives a bachelor's degree after four years is transformed into 0 or 1. In our case, there are 18 condition attributes and one decision attribute.

Step 2. Feature reduction using RST

Applying RST, we found that we could not get the approximate results in Matlab. The excessive number of condition attributes causes this. Straightforwardly, specialized courses are inherited and are more likely to lead to academic failure. Therefore, we check the content of the required courses, remove public courses such as Principles of Marxist Philosophy and Introduction to Mao Zedong Thought, and reduce the number of condition attributes to 12. The reducts after applying RTS are shown in Table 1. Hence, A3, A10, and A11 represent the core attributes of the information system.

Table 1. Reducts from the dataset

Reduct no.	Reducts	Length
R1	A3, A6, A8, A9, A10, A11	6
R2	A3 A4, A5, A8, A10, A11, A16	7
R3	A3 A5, A7, A8, A10, A11, A16	7
...	...	...
R34	A3 A4, A5, A6, A9, A10, A11, A13, A16	9
R35	A3 A4, A5, A6, A9, A10, A11, A12, A13	9
R36	A3, A4, A5, A9, A10, A11, A12, A13, A16	9

Step 3. Training with the back-propagation neural network

The 36 reducts indicated in Table 1 are fed to the neural network individually and trained using the back-propagation algorithm. A two-layered feed-forward network employing a sigmoid function is used. Table 2 demonstrates the loss and accuracy of the model. As a comparison, we also use all the 18 input features directly to train the system, without reducing any input features. It infers that R1 having six input features is best suited for the model. To choose the best reduct among these, the model has the highest accuracy and lowest loss. The accuracy, which is 0.8276, is 7% better than the model with all input features.

Table 2. Comparison of loss and accuracy

Reduct no.	Loss	Accuracy
R1	0.2712	0.8276
R2	0.3692	0.8276
R3	0.6539	0.7931
...	...	...
R34	0.4792	0.8276
R35	0.5347	0.7241
R36	0.3885	0.7586
All condition attributes	0.7008	0.7586

III. Conclusion

The four years in university are a crucial period in a student's lifetime. With the assistance of an early warning system, we can effectively save students' academic performance by detecting the struggles they face at an early stage and providing immediate intervention and assistance. This paper attempted to propose a hybrid architecture that links RST with neural network to predict the students` academic future to deal with the problem。RST is used as a preprocessing layer part of the neural network to filter out the irrelevant attributes. The experimental results show that the prediction accuracy of the neural network trained with the best reduct is higher than that of the model using all features. It is an effective early academic warning model.

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