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Prediction and Evaluation of Students Academic Performance using Fuzzy Logic

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Abstract - *This paper presents a new fuzzy logic based approach for performance evaluation of students in school or college. The prediction of student academic performance is important to both educational institutions and students as well for a various purposes. In this system we employ the use of fuzzy logic for the evaluation of students performance which gives a lenient and appropriate output to the students. However, previous techniques often consider only past numeric data for prediction, leading to the creation of complicated predicting methods whose results are difficult to interpret. This paper proposes a novel approach to predicting student final period grade, using attributes related to student past academic records and attributes of normal study behaviour, which are readily obtainable and easily interpretable.*

Key Words: Fuzzy logic, Prediction, student performance, Evaluation.

1. INTRODUCTION

The prediction of student academic performance plays an important role in educational institutions, especially for higher educational institutions such as universities and colleges. For example, when reviewing applications from prospective students, the prediction may help higher educational institutions to find candidates who are eligible for a particular academic program and identify those applicants who are likely to perform well in future study . In the process of dealing with student application, the final period grades are usually regarded as the benchmark for evaluation and unfortunately, are always not available at the time when receiving student applications. Thus, methods of predicting the likelihood of student performance in their final period exam are necessary. This is also the case for individual students; accurate prediction for the final period grade would help them to choose institution and subject discipline when applying for higher education. More generally speaking, predicted results of academic performance for students already at a certain educational institution are also very useful, enabling the educational institution to provide them with appropriate additional support such as customised personal assistance and tutoring resources. Also, predicting student academic grade offers a feasible means to handle emergencies where a student fails to attend an exam due to inevitable reasons, such as physical injury or other medical situations. There may even be cases where a number of students in the same course fail to attend the exam because of unavoidable weather conditions or a natural disaster. Additionally, the results of prediction can be used by lecturers to specify the most appropriate teaching materials and actions for each group of students to meet their needs, and by students themselves in making informed decision for seeking suitable employment. For any of these cases, successfully predicting student exam scores and using them as evidence to evaluate student academic performance offers great potential benefits. Thus, developing a prediction tool is very important for educational institutions. Over the past years, methods for data mining and machine learning have been applied in the area of education, although at a rather coarse level compared their usage in other academic fields. For instance, artificial neural networks have been employed to predicting student academic performance in an engineering course. An alternative for training neural networks in an effort to predict student performance was introduced in. A neuro-fuzzy approach for classifying students through academic performance prediction in a conventional classroom context has been reported in , and an attempt to predict student exam scores by analysing social network data between students has also been made . In a more broad sense of addressing the problem of predicting student academic performance, a number of proposed methods work based on the use of large quantities of previous exam results. For example, student performance in prior academic courses is used to predict their performance in a subsequent course. It has been shown that previous success in high school mathematics and science has a positive correlation with the study of computer science at universities. Also, high school performance and background in mathematics is utilised to predict final exam grades in an introductory computer science course. Apart from previous academic records, different types of other attributes, including age and gender, , and even the complexity measure of lecture notes have been taken into consideration in the existing work. Whilst researching into relationships between student academic performance and a wide variety of individual attributes is meaningful and worthwhile, the overuse of different types of indicative attribute has led to the creation of complicated score predicting methods which may be difficult to implement and whose results may be difficult to interpret. Certain types of attribute may not be easy to obtain during the normal teaching process. Moreover, previous methods for prediction may be excessively focused on the relationship between student

academic performance and a particular type of attribute, ignoring the fact that such performance is a synthesised consequence of many reasons. Having taken notice of this, a novel approach to predicting student academic performance is proposed here, based on the synthesis of just basic attributes that are related to the academic course and the students' normal study behaviour. The rest of this paper is arranged as follows. Section II introduces the proposed architecture for building an intelligent system to predict students academic performance, describes the functionality of each component within the system, and analyses their complexity. Section III shows the experimental results, supported by comparative studies with the real grades and other methods of prediction. Section IV concludes the paper with suggestions for further development.

2. METHODOLOGY

Fuzzy Methodology involves the steps as shown in Fig. 1:

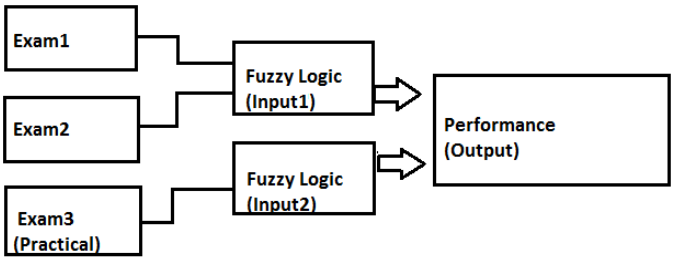

Fig.1 Fuzzy methodology diagram

Here, there are three input variables. Then we two output variables that ended to performance.

Academic performance evaluation with fuzzy logic involved three steps:

1. Fuzzification of various examination outcomes and output performance value.
2. Determination of relevance rules and inference method.
3. Defuzzification of performance value.

3. PREDICTING SYSTEM

This section presents the proposed general framework to predict student final period grade, including the description of its component subsystems and their working.

A. System Structure

The structure of the proposed predicting system is shown in Fig. 1. It comprises four distinct component subsystems, each of which implements the following functionalities, respectively: partition, regression, offset value generation and estimation. These activities are integrated together to form the overall student score-predicting mechanism, whose implementation involves a 4-step computational algorithm:

1) Partition data of sample students (typically from previous years on the same course, whose final period grades are available) into different categories based on the similarities of their existing academic records (not including their final period grade), and obtain the fuzzy membership values for each of the sample students with regard to different partitions.

2) Determine for each partition, the relationship between the final period grade and the previous records in the academic module concerned.

3) Generate the offset value of the predicted final period grade for the target student according to the similarity of the student's own normal study behaviour and the behaviour of other students with the same or similar previous academic records.

4) Estimate the predicted final period grade of the target student based on the fuzzy membership values obtained in step 1, the relationship determined in step 2, and the offset value acquired in step 3.

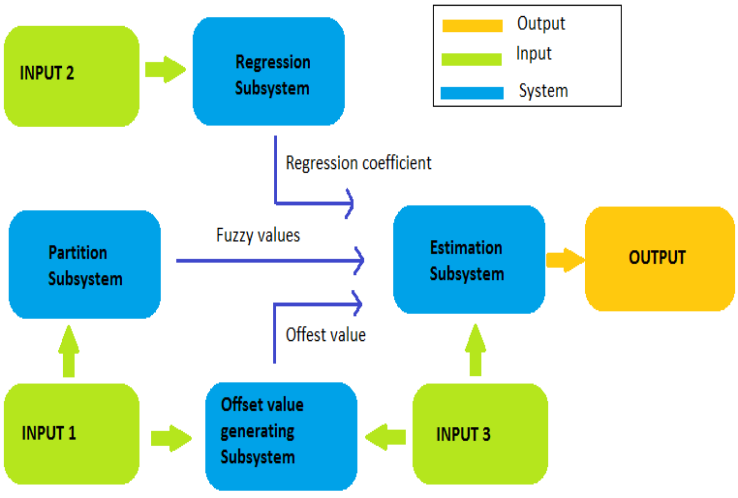

Fig. 2 Architecture of the predicting System.

B. Partition Subsystem

Let an academic record list of n students be the input of the partition subsystem. In general, each record in the list, describing a student with their previous grade and final period grade (the grade values are in numeric form) for a given academic module, forms an instance of the training dataset. The aim of the partition subsystem is to divide the instances regarding a certain module into different categories

C. Regression Subsystem

Regression analysis is a popular statistical process for estimating the relationships among variables, which has been widely applied. It is utilised here as a segment to predict student final period grade. In particular, multi-variable linear regression, a highly flexible mechanism for examining the relationship of a collection of independent variables with a single dependent variable [14], is an appropriate choice to perform the prediction.

D. Offset Value Generating Subsystem

In practice, predicting student academic performance by considering previous records only is not always sufficient. It is not surprising that students may achieve quite different results in their final period even if they have had the same or similar achievements at previous stages. This reality makes the task of reaching highly accurate prediction a challenge. Having taken notice of this, aspects other than just the student previous academic records need to be taken into account in order to generate better predicting results. Nowadays, it is commonly recognised that the study behaviour has a significant impact upon student academic achievement [15], making it an interesting factor worth investigating. The present subsystem is developed in an effort to optimise predicted final period grade, by generating an offset value to the interim predicted final period grade for a given (target) student.

E. Output

The output of the system will be the evaluation of the students academic performance related to their respective academics grades and suggestions regarding the same.

4. CONCLUSION

This paper has proposed a novel approach to predicting student performance in academic courses. Unlike simple clustering regression analysis which takes part of the precise sample data into consideration, the proposed approach processes the universal data . This has an intuitive appeal in handling a large number of student academic records which are typically normally and continuously distributed. The work makes use of attributes that are related to observed student study behaviour, by introducing an offset value in the predicting model. The implementation of the embedded fuzzy clustering approach, supported by the offset value mechanism, generates better results than the existing methods. With fuzzy representation, the approach synthesises the use of intuitive attributes from an academic course and from student normal study behaviour. This helps make the predicted results more readily interpretable, while involving simple computation.

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BIOGRAPHY

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