REVIE OF ACADEMIC PERFORMANCE USING SOFT COMPUTING TECHNIQUES

Dr. Ramjeet Singh Yadav

Department of Computer Science and Engineering, Ashoka Institute of Technology and Management, Engineering Chauraha, Paharia, Sarnath, Varanasi-221007, UP, India

ABSTRACT:

This review paper gives as details and overall review of methodologies and present scenario related to student’s academic performance evaluation for the development of better understanding. The present paper elaborates several aspects of students performance evaluation (prediction of student performance, modeling student performance from available data and grouping student on need base criteria). Apart from this, selected methods used for student’s academic performance evaluation and soft computing techniques have been described.

Keywords: Academic Performance, Fuzzy Logic, Neural Network, Probabilistic Neural Network, Soft Computing.

[1] INTRODUCTION

Student academic performance evaluation involves multiple modules; each one is based on multiple variant imprecise judgmental matrixes rising due to human (teacher/tutor) interpretation. Both mathematical and statistical procedures have been used for collating information from these multiple modules in the educational domain. The commonly used procedure has some limitations. For example, in a scenario two student’s scores are fifty, sixty, seventy and seventy, sixty, fifty in three assessment, respectively. The mean score secured by each is sixty without any indication of their intelligence level. However, the assessment pattern shows that the one learner is improving in percentage terms and whiles other showing decreasing trend. Recently, methods have been developed for the application of fuzzy set theory in student performance evaluation and concept map construction which provides adaptive learning guidance to students. Learning achievement evaluation needs solution of the subjective judging problem, difficulty and complexity of questions faced by the teachers [1]. Concept map constructions for adaptive learning guidance to students require consideration of achievement similarity between concepts [2].

The main purpose of the education service provider is to asses’ student/learner with the feedback/examination report pertaining to their assessment with minimum errors. Some factors other than academic have been reported to hinder students’ performance maximization efforts and maintaining their optimum performance [3]. Applying clustering techniques of student
performance using cognitive as well as a changing factor to redefine performance matrix is well defined approach. Applying fuzzy sets in students’ answerscript evaluation (Fuzzy evaluation method) may serve the purpose. The fuzzy marks awarded to student’s answerscripts can be expressed as fuzzy sets [4]. The present study argued that the arithmetical and statistical methods for classification and awarding the student academic performance have several limitations and are less appropriate to evaluate knowledge and skills. The present thesis includes the role of fuzzy logic system, and various properties of fuzzy logic system, linguistic variables, rules and membership functions and the implementation of the performance analysis methodology to aid of fuzzy logic system. Reasoning based on fuzzy models and fuzzy clustering methods may yield alternative methods having potential to handle various kinds of imprecise data and improve the degree of judgments.

Some works related to academic performance evaluation based on Fuzzy sets and other soft computing techniques have been developed. Methods based on fuzzy sets and fuzzy rule base to assign grades to students and calculate the students’ academic performance are available [5-6]. Soft computing techniques (such as fuzzy logic, probabilistic reasoning, set theory and various other mathematical techniques) can also be applied to various forms of decision making in research on Engineering and Artificial Intelligence (AI) [7]. A fuzzy system, a mathematical model, that analyzes input values in terms of logical values in addition to integer values. Nonlinguistic grammar rules are applied to represent real world facts in fuzzy logic applications. The performance evaluation system can be applied using Fuzzy Logic techniques [8] as in the present study. A cascaded fuzzy inference system based on specific performance appraisal has been used to represent the performance gradient of non-teaching staff of Universities [9-10]. Recently the fuzzy qualitative classification system for academic performance evaluation using the link analysis methodology has been developed. Fuzzy rules based models involves objects and their interrelationship to implement a social network which can be represented as a weighted graph [11]. A more recent approach towards student(s) performance evaluation has been proposed by Hameed based on Gaussian membership function [12] involving fuzzification, fuzzy inference system, and defuzzification, has been considered. The fuzzy expert system based on various key performance attributes is available to evaluate teacher’s performance [13]. Also the fuzzy method has been applied in the evaluation of student’s oral presentation which involves application of membership function graph to identify the membership value of each satisfaction level [14-15]. Fuzzy logic based engineering student’s evaluation for practical [16-17]. Such student’s performance in three subcomponents showed a difference in outcome compared to classical approaches. The fuzzy based method to consider the conventional number based system and evaluates the performance of students without using human intervention components [18]. Evaluations of Government officer’s performance with the help of various parameters have been carried out by applying fuzzy inference system (FIS) [19]. This helps in the formulation of mapping from a given input. The fuzzy logic systems facilitate evaluation of distance learning education learners’ performance, according to the expert opinion [20-21]. FIS for academic performance is based on Fuzzy Logic Techniques and it relies on semester score, which is logically calculated as pass/fail [22]. Methods to assess the student academic performance of junior students [23], performance of teachers [24], and determination of grades to the students [25] are available. System considering the difficulty, importance and complexity of each and every question before calculating the final result [26] has also been worked out. Considerable importance to adopt has been given to fuzzy logic techniques for teacher performance evaluation by using
computers, particularly in Intelligent Tutoring Systems and CAI (Computer Assisted Instruction) [27-28]. Fuzzy approaches have been proposed for the determination of the student’s context capture level of various subjects with respect to ITS (Intelligent Tutoring Systems), and student academic performance based on various components with a huge suggestion that the techniques be applied to CAI. Currently, much attention has been given to such aspects globally. Knowledge Discovery using Data Mining (DM) is an approach for sorting important information from very large data set [29]. Data mining techniques are applied to very large data set to discover and extract patterns from stored data set, and are widely used in educational field to find out hidden patterns. Educational data mining is the focus of research for studying the behavior of students based upon their past performance [30-33].

Fuzzy Probabilistic Neural Network model, enabling design of an easy-to-use, personalized student performance prediction component [34]. Techniques to measure the teacher’s performance using Neuro-fuzzy system for online monitoring have been worked out [35]. A Neuro-fuzzy approach for classifying students based on previous exam results and other related factors show potential for labeling students to anticipate academic performance [36]. Bayesian neural networks to predict the student's academic performance and generate a model which helps in identifying the walked out students needing specific attention from teacher for much needed counseling [37]. The Neural Network model is able to provide an adequate model for predicting performance evaluation effectively [38]. The Artificial Neural Networks (ANNs) have been used for children performance evaluation [39]. An Artificial Neural Network (ANN) model reported along with computation also derives meaning from imprecise data, extracts patterns and detects trends [40-41]. This advancement adds new dimensions in working out the complex phenomena that are buried in students’ data remained unnoticed by hard computing techniques. A type of Neuro-fuzzy inference system is modeled in the framework of adaptive networks, called Neuro-fuzzy inference system (ANFIS) [42]. ANFIS utilizes a hybrid algorithm (gradient descent and least squares estimates) and constructs an input-output mapping both based on human knowledge (as fuzzy if-then rules) and produces input-output data.

Soft computing is a near approximate solution to a pin point formulated problem, or an imprecisely formulated problem [43]. The use of soft computing techniques for academic performance evaluation is fairly new approach. In addition to evaluation of student academic performance, wide applications of soft computing include the evaluation of educational curriculum. Student academic performance evaluations, fuzzy techniques utilizing previous achievement of student based on numerical scores obtained in previous examination are utilized. The Emerging soft computing paradigm (artificial neural network (ANN), fuzzy logic (FL), adaptive Neuro-fuzzy inference system (ANFIS) and regression analysis) have the capability of the human mind of reasoning and learning using highly imprecise probabilistic data set [44]. The extensive computing power to perform ultra-complex mathematical mapping is a function of artificial neural network (ANN) model, which is a system of interconnected computational neurons arranged in an arranged mesh network model [45]. An in-depth consideration of available approaches (fuzzy logic, neural network and fuzzy neural network) indicates that membership function and fuzzy rules have been defined by the experts which may lead to errors and make them less suitable for evaluation of students’ performance. Generally overlooked, automatic generation of fuzzy membership function and rules are promising and need a fresh insight.
[2] PROBLEM IDENTIFICATION

The present section provides the summary of “student academic performance evaluation” and identify research problem domain/elicit research objectives of the present work.

[2.1] OVERVIEW OF STUDENTS ACADEMIC PERFORMANCE

Academic performance evaluation of learner/student performances are one of the major tasks associated with any educational domain. The main objective behind this activity is providing a simple numerical/letter grade, which can be easily interpreted and interchange between all stakeholders (students, teachers, parents, employers and policy planners).

[2.2] REASONS FOR STUDENTS ACADEMIC PERFORMANCE

There are various need based criteria which required “student academic performance evaluation”. Firstly, the performance level of student is a measure of understanding level. This assessment of student is very important for the tutor in taking suitable remedial measures. The feedback from examination provides valuable input to student to remove weakness and enhance his/her strong point(s) [46]. Secondly, student academic performance evaluation is important in any academic framework in determining the proper course of action. For example, the student performance determines his/her flow in any academic intuition. Assessment is the most important student performance parameter which can be used in different scale of gradation schemes; it has long lasting effect on future career of student(s) [47]. Thirdly, assessment is very useful 360° evaluation tool to provide important feedback regarding instructor ability and capability. The reasons for assessing students [48] may be summarized as follows:

1. To provide valuable input on the effectiveness of teaching staff.
2. To determine academic aim achieved.
3. To find out the effectiveness of the learning environment.
4. To decide standard over time, if required.

[2.3] FORMAT OF ACADEMIC PERFORMANCE

Academic performance evaluation can be achieved in two ways (a) Formative assessment (b) Summative assessment. Formative assessment is an important construct to monitor the effectiveness of instructions and this is a useful tool to provide feedback to student(s)/teacher(s) [49]. Formative assessment is often called as continuous assessment. Formative assessment is usually applied on frequent evaluation task which may or may not be grade oriented (e.g. A series of observations, short tests and quizzes etc.). Summative assessment is usually applied on semester/yearly examinations to acquire valuable information regarding the student(s) evaluation in given time [48]. The final evaluation is the cumulative sum of (1) Summative assessment (2) Formative assessment. There are various practical reasons for using this combination, e.g.:

1. Various assessment techniques have different goals to effectively measure students’ performance. There is a wide range of continuous evaluation techniques which can be applied to evaluate such aspect of student performance, not easily measured by semester/yearly examinations (for example classroom observations, essays, homework, open book examinations, debate and painting). Few tasks may be more suitable to evaluate
what cannot be evaluated in semester/yearly examinations (e.g., investigation and group work). Semester/yearly examinations at the end of the course may not provide comprehensive picture of student(s) performance [50].

2. Assessment and teaching is a side by side activity to get a more comprehensive picture of student performance/evaluation [51]. Continuous assessment is a fine example of a tool to get early and comprehensive feedback. Continuous assessment and error pattern subsequently leads to valuable input regarding student(s) knowledge acquisition.

3. Culmination of various assessment methods are generally considered to as providing maximum coverage of important learning outcome(s) [52-53]. Multiple assessments determine clearly measure for educational experience.

4. Higher grades in the Continuous performance assessment provide a morale booster to further their efforts for semester/yearly examination.

Various models of performance evaluation methodologies have been used for basic, secondary and tertiary education. Wide spectrum of evaluation methodologies also exists in different geologies (e.g., in 1996 there have been at least 137 different strategies of evaluation [54] in Scottish Higher Education reflecting their wide amplitude.

[2.4] ASSESSMENT COMPONENTS

Student academic performance evaluation usually consists of multiple modules. These modules at a very basic level applies continuous assessment methodologies (e.g., Series of tests and quizzes, debate, written tests, Individual Assignment and Coursework, Group work, Observations, Thesis and Publishable materials, Painting and Oral presentations). Different module of continuous evaluation measures different capability matrix of a student.

[2.5] EXISTING METHODS OF ACADEMIC PERFORMANCE

Student academic performance evaluation awards numerical scores or grades with respect to their examination effort. Different mathematical approach (arithmetical and statistical) is applied to numerical or literal grades obtain by a student(s). A combination of various assessment algorithms has been used for multiple allocation patterns of numerical marks exists in different places. By using arithmetical method, for example summation technique for each assessment to receive a single grade. Statistical methods, for example mean technique for each assessment are also utilized often. Further, student scores are amenable to more sophisticated statistical approach (e.g., mean, median, mode, range, standard deviation, skewness, variance, Z-score).

The methods which usually represent student’s academic performance can be divided into following categories:

1. Literal grade (for example A, B, C, D, E, F). Literal grad are usually established on certain class interval (for example, below <49 grade C, 50-59 grade B, >60 grade A, >75 grade A+).
2. In certain important examination conducted by educational institutions, uses the percentile numerical grading system. For example, student having a maximum score got the numerical grade of 10 and subsequently all other students graded from scale 1 to 10.
3. Maximum percentile or 10 are referred to as 100.
4. In many cases literal terms Pass/Fail is often used.
5. Suppose that in Single ‘fine’ grade-points the interval ranges from 0.0 to 4.0 and period interval is 0.01 (e.g., 0.00, 0.01, 0.02,..., 0.1, n=4) based on Grade-Point Average (GPA) and Cumulative Grade-Point Average (CGPA). Combination of various methods has been also used, i.e. the use of GPA alongside the linguistic grade. Numerical scores are predominantly useful for student performance evaluation because numbers can further subject to arithmetical or statistical analysis.

[3] RESEARCH PROBLEM

The student accessing the quiz and test in educational domain is normal activities to evaluate the student performance. Normally, score is used as a factor for identifying the student performance. However, multi-dimensional evaluation methodologies pose a new set of complexity (for example semester1, semester2, semester3, sessional marks, attendance etc.). Very often this results in misleading evaluations of students on short time basis. Common use of Grade Point Average (GPA) as is computed from student’s aggregated numeric grade using statistical measures. The aggregation does not reflect student’s Continuous Performance Assessments (CPA). Also, the statistical measures (like average) may lead to a wrong conclusion. Soft computing techniques used for student performance evaluation in the present work aim to reduce the shortcoming in the traditional systems and provide a robust and more reliable alternative for the user.

[4] SCOPE OF STUDY

This study aims to develop a fuzzy systems and other related soft computing techniques like fuzzy clustering and Neuro Fuzzy Systems for academic performance evaluation. These methods provide a channel (associated inference mechanism) in soft computing, which is utilized for student academic performance evaluation.

[5] FOCUS OF STUDY

For the purpose of the research, traditional statistical methods are used (referred hereafter as non fuzzy models) for student academic performance evaluation. Due to multiplicity of traditional educational evaluation methods, this research will bring down a new approach (High level) of a student’s academic performance evaluation. The methods proposed will take into account the existing student examination data and aggregate function will be applied on individual set to get aggregate scores which will be an effective input for individual modules, another set of aggregation results from different module results in a matrix of yearly performance and aggregating different year performance to produce an overall performance.

[6] CONCLUSION

This paper review the basic objective in the educational institutes focuses on the accuracy and relevance of the student’s evaluation report in the best possible manner with minimum errors. In addition to academic factors other factor also plays a critical role with regard to student attainment and performance. Classifying (i.e. grouping or clustering) students based on cognitive and affective factors and then determining their performance may be a more realistic approach. The present investigation revealed that both arithmetical and statistical techniques suffer from several limitations making them less appropriate for this purpose. Reasoning based
fuzzy models and fuzzy clustering have potential to yield better alternative methods more suitable for the handling of varying imprecise data and improvement of judgments.

Contemporarily, soft computing techniques are and have been proven good for “e-learning, intelligent tutoring systems, adaptive hypermedia and data mining” by taking into account the type of data, computing techniques and the type of educational task assigned. In academics, appropriate integration of soft computing techniques and their functional implementation can emerge as the concurrent need in various fields. Emerging soft computing approach parallels the numerous and varying abilities of the human mind to argue and learn even under the uncertainty and imprecision.

REFERENCES


