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A Study on Fuzzy Decision Support Model for Predicting Student Academic Performance

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Abstract

It is vital to evaluate the academic accomplishment of pupils in order to identify whether or not a school's teaching methods are effective and to ascertain whether adjustments are required. When it comes to creating accurate predictions regarding academic performance, there are a number of quantitative and qualitative factors that come into play. Some of these factors include socioeconomic position, motivation, cognitive ability, assignment scores, engagement, and attendance. Because of the inherent fuzziness and unpredictability of these variables, it is possible that conventional statistical methods will not be able to fully capture them. The response that fuzzy logic offers in this context is a powerful one because it offers a framework for organised decision-making that can handle information that is imprecise, subjective, and linguistic in nature. The primary objective of this effort is to develop a fuzzy decision support model that can accurately predict the academic progress of pupils. A fuzzy inference approach is utilised by the model in order to handle a wide range of input elements. This allows the model to produce a projected assessment that is indicative of the actual uncertainty that is observed in academic contexts. In terms of flexibility and interpretability, the recommended method exceeds traditional models that are rigid in their approach. This is because it simulates a broad variety of educational scenarios.

Keywords: Fuzzy Logic, Decision Support System, Student Academic Performance, Predictive Modeling, Educational Data Analysis

Introduction

When it comes to the field of education, one of the most crucial things to accomplish is to conduct performance evaluations. At universities, the process of performance assessment is carried out by stakeholders, who are academics who are associated to the institution. The evaluation is carried out with the purpose of analyzing the evolution of student performance over the course of a set amount of time throughout the learning period. The method of evaluating performance is very reliant on the numerous assessment outcomes that have been established as a reference standard in the process of conducting assessments. In general, the assessment procedure is based on the grade point average (GPA) of the students. This is a method of classifying the GPA scores depending on the range of a preset group, some examples of which are bad, good, very good, and exceptional.

A significant portion of the evaluation procedure that is conducted out on the performance of the GPA is comprised of assessment. By analyzing their data warehouse, academic performance evaluation is one of the effective ways that can be used to discover student failure difficulties. This ensures that the data warehouse can assist in providing crucial information that can be used in the process of evaluating the students' academic performance. When it comes to performance evaluation, the laborious task of assessing performance is carried out primarily on the basis of the traditional assessment approach, which is the standard grade point average evaluation. While the classical assessment technique is a manner of giving an evaluation that is based on a comparison of the outcomes of student performance with the standard GPA value category that has been established, the modern assessment method employs a different approach. When utilized as a foundation for assessing student achievement, this is a disadvantage in comparison to the traditional evaluation approach, which is represented by the conventional grade point average assessment. When it comes to the evaluation process, it would be very unjust to merely review and generate a choice by taking into consideration a single component (GPA), without taking into consideration the variables that impact the attainment of the GPA score as the present standard of assessment.

Objectives

1. To study on the creation of a computational model that is able to successfully replicate the human decision-making process.

2. To study on explanation of educational psychology.

ACADEMIC PERFORMANCE

Academic performance, sometimes referred to as Advanced Placement (AP), is a kind of educational outcome that evaluates the extent to which students, teachers, or educational institutions have been successful in achieving their educational goals. The process of obtaining knowledge and being evaluated based on the value that is given by the teacher is another definition of advanced placement (AP). This definition depicts the process as a process that includes collecting information. Advanced Placement (AP) is a term that is used in the area of education to describe the process by which students, teachers, or schools are able to achieve their educational goals within a certain amount of time. The evaluation of these goals is carried out by periodic evaluations and/or examinations, and the objectives may differ from one student to the next and from one school to the other. Academic performance is a process that occurs during the learning process within a certain length of time and aims to attain an educational goal, specifically an academic achievement. This process takes place in an effort to complete the learning process. Subsequently, this achievement is evaluated based on the value that is offered by the teacher, or via a testing procedure or a regularly scheduled examination. The academic performance of the student provides an overview of the student's ability to grasp and study a particular learning issue, which then becomes a provision for the acquisition of knowledge that is more complex.

DECISION SUPPORT MODEL

Micheal S. Scott Morton was the first person to present the decision-making model, and he did it in the early 1970s under the name management decision system [9]. The decision-making model, also known as the decision support model (DSM), is a concept that is defined by a computer-based interactive system that assists in the process of decision-making by leveraging data and techniques to address issues that are not organized. All phases of decision making are intended to be supported by the DSM, beginning with the identification of issues, followed by the selection of data, the selection of a strategy that will be used in the decision-making process, and finally the evaluation of potential alternatives. Components of the model, components of the data, and user interfaces are the key elements that must be included in the notion of the decision-making model.

One approach to resolving issues that arise in any business process is to use a decision-making model. A dilemma is the foundation upon which a choice is made, and the decision is made in an attempt to accomplish a certain objective. The Decision Support Model (DSM) is not a tool for making choices; rather, it is a model that is built by providing individuals with information from data that has been processed in a relevant manner and is required to make decisions about an issue in a business or organization in a more timely and correct manner. The DSM asserts that it is able to handle issues that are expressly derived from semi-structured problems. During another conversation, it was said that decision-making models have the ability to solve some issues mathematically. This is the case when the model is constructed with the best option in order to provide an objective solution to address the difficulties that are currently being faced.

The method of evaluating academic achievement is still in the process of being explored and scientifically researched, and new models to support objectives are currently being developed. A study that is connected to the DSM is one of them. The DSM has been the primary focus of study conducted by a number of researchers who have conducted their investigations. In the DSM, there have been a number of research that have proposed a variety of approaches that may be used for the evaluation of AP. A performance-based academic decision-support system, also known as PADSS, is used in order to make judgments on the outcomes of academic performance. The PADSS system was developed in order to fulfill the need of evaluating performance outcomes with the GPA parameter serving as the primary parameter. The PADSS framework is nevertheless of a generic character and may be used for the purpose of evaluating APs, despite the fact that the data that PADSS uses are particular to case studies.

RESEARCH FRAMEWORK

In the process of doing research, the research framework outlines the manner in which the research idea will be translated into action. The AP assessment process, which is a research topic, is carried out by developing a DSM as a solution to the problem of problem-solving. The first thing that has to be done is to determine the issues that are being experienced by FTTE, which is the most numerous faculty at Mulawarman University which is located in East Kalimantan. There is a greater emphasis placed on indicators of grade point average success when it comes to evaluating the academic performance of students at Mulawarman University via the FTTE. Increasing the value of the grade point average is often the primary emphasis of policymakers. As a result, a number of policies are centered on the goal of raising the grade point average over a certain amount of time. The GPA indicator does not address the supporting variables for reaching the GPA value from a variety of aspects, such as the familial, social, cultural, economic, educational environment, and technology. Instead, it focuses on enhancing academic accomplishment via the GPA indicator.

In order to provide assistance for the academic evaluation process that is carried out by FTTE, the traditional assessment approach does not meticulously examine the aspects that contribute to the grade point average. The stages of the Advanced Placement (AP) assessment of students in higher education are very important for every educational institution. This is due to the fact that the quality of education provided by an educational institution will have an effect on the accreditation assessment for FTTE, which is responsible for maintaining and continuously improving the quality of graduations produced each year. It is determined that students are able to offer input in the form of knowledge about Advanced Placement (AP) accomplishments made by each individual student if they take rapid actions and apply techniques by identifying and arranging individuals based on their academic performance. This stage serves as an assessment material that is used to identify the appropriate plan to enhance the accomplishment of academic performance for each person who has a low academic performance. As a result, this research carried out a literature review in order to improve the foundation about the ideas, methodologies, and parameters that are used in the construction of a decision-making model that is intended to carry out advanced placement and evaluation for students.

The model that was established is referred to as DSM-AP, and it was constructed by determining and assigning weights to the parameters that were going to be utilized as input parameters in the model. Additionally, the model makes use of a mix of three different methods: algebraic model, conventional model, and FL Sugeno. The subsequent stage is to gather data for the purpose of conducting a later analysis of data needs associated with the AP assessment, which includes the process of data pre-processing. In the end, the data that was gathered from the analysis will be used as a data source (dataset) that will be utilized in the process of constructing the model.

RESEARCH STAGES

Each of the phases of study is derived from The process of analyzing actual instances in terms of AP evaluation is the first phase in the research process. This step is backed by the findings of reviewing various scientific articles that are relevant to research concerns. Both of these processes are carried out in order to increase the amount of knowledge that is relevant to research concerns with AS assessment. Following this, the factors that are associated with the evaluation of AP should be defined based on the findings of the literature review. When it comes to doing AP evaluation, related research that involves a variety of factors that have been verified based on a variety of references from earlier studies is going to be used. It is necessary to integrate all of the collected parameters in order to construct the model, which consists of a total of seventeen parameters. Following this, all of the parameters will be specified, which includes the configuration of the parameter grouping as well as the configuration of the parameter weighting. Following the successful completion of the process of parameter preparation, the next step is to gather data in order to prepare it for use as a dataset. This is accomplished by going through the process of data pre-processing.

SELECTED PARAMETERS

In this part, the procedure and reasons behind the selection of parameters that will be used in the construction of the model are discussed. For the purpose of determining the parameters that were used, references from earlier studies that are closely linked to the subject of the study were utilized. The factors that have been suggested in earlier research were gathered and merged in this investigation. This was accomplished by showing them in the Venn diagram shown in Figure 1, and the weight of the parameters was derived from the prior research.

Dataset Resource

There were two methods that were utilized in order to collect the dataset that was utilized in the study. The first method involved the distribution of online questionnaires through the use of Google Forms services in order to collect profile data from each student. The second method involved downloading the student academic data archives that were contained within the SIA at FTTE of Mulawarman University, East Kalimantan. The data collection that was carried out contains student data for the 2019/2020 academic year, with the quantity of data for academic performance evaluation reaching 100 data. The dataset that was used may represent a wide population in the FTTE environment, and there are many data variants for each input value that was utilized. for the purpose of testing the model. TABLE 1 provides a description of the form that will be utilized for the dataset, which is the data format that will be explained.

Parameter Grouping

All of the parameters that are used in the model are grouped together in this subchapter in order to provide an explanation of the parameter setup. Additionally, the approach that will be applied to each parameter group will be differentiated depending on the data type, which is based on the fact that the configuration stage is based on the use of research data types in the form of numeric and nominal data. The process of parameter grouping involves splitting the group into two groups of parameters, which are as follows: the fuzzy parameter group is represented by to be operated on the numeric data type, and the conventional parameter group is represented by bx to be operated on the nominal data type. In the parameter, further configuration is carried out by encrypting the data, which includes the properties of each parameter, using the bx encryption algorithm. The Boolean data type is used to structure attribute values that are in the form of nominal data. These values are then converted into quantitative data. In the context of performance evaluation, an attribute value of 0 represents the ideal state of an input value, while an attribute value of 1 represents a specific circumstance that has an effect on the evaluation of performance.

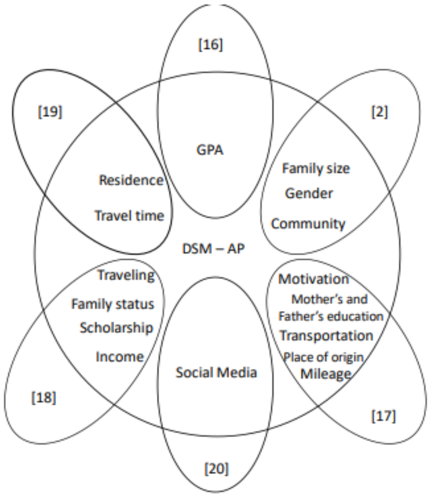

Figure 1. Diagram Venn of Selected Parameters

Table 1 Collected Dataset

No	P1	P2	P3	P4	P5	P6	P7	…	P12	P13	P14	P15	P16	P17
1	M	OT	1	DE	H	1	1	…	PB	Y	Y	4	2	3,56
2	F	T	3	L	P	3	2	…	PR	N	Y	4	4	2,41
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
99	F	OT	3	L	P	4	3	…	PR	N	N	6	2	3,57
100	M	OT	3	L	P	4	3	…	PR	N	N	8	4	3,19

Variable Analysis

Influence diagrams are a tool that are used in the field of engineering to describe a decision model in a graphical format. These diagrams are used to aid in the design of models, the construction of systems, and the comprehension of such systems. As can be seen in Figure 2, the author employs influence diagrams in the process of constructing the model in order to provide the graphical representation of the model.

It is possible to observe, on the basis of the impact diagram shown in Figure 2, that the hexagonal symbol that represents the output of the study is to decide the choice in the form of the final assessment result (decision value) of the academic performance of the students within a certain amount of time. This is the output that is anticipated to be produced by the model in the process of resolving the current difficulties (decision indicators). The output (DV) results are generated based on the AP assessment, which is determined based on two primary parameters that are input to the model. These parameters are the fuzzy group and the conventional group bx. The two main parameters are impacted by other factors. The AP assessment is used to determine the output (DV) results.

There are nine factors that have an impact on the, and they are as follows: grade point average, duration of journey, distance traveled, education level of mother and father, income of family, number of siblings, travel style, and social media are all factors. There are eight characteristics that have an effect on the bx, and they are as follows: scholarship, the form of transportation, family situation, motivation, gender, origin region, community, and dwelling location. A mixture of three different approaches, namely FL Sugeno, traditional, and mathematical models, were used in the construction of the model.

Construction of a Model

This section provides an overview of the process of developing a model for AP assessment, which is presented in a high-level modelling format. The DSM's fundamental structure was taken into consideration while designing the arrangement of the model that was then constructed. Based on the findings of the literature review, the configuration is carried out at the beginning of the process by deciding which parameters will be used in the construction of the DSM-AP model. The results of determining the parameters will also be carried out in two different configurations, which are known as grouping and parameter weighting. The grouping configuration is carried out by forming two different types of parameter groups, which are referred to as ax representing the parameters for the FL Sugeno method and bx representing the parameters for the conventional method. The grouping is based on the calculation method that is applied to the model and the type of data type that is used as the model input value. The subsequent configuration is weighting, which is carried out in two stages: first, an estimated initial weight calculation of each parameter is produced based on data collected in the field, which is carried out with the help of the RapidMiner tool; then, the results of the initial weight estimate are normalized in order to obtain the final weight value.

Once the value in the parameter attribute bx has been determined, the subsequent configuration may be carried out. The outcomes of this configuration are shown in Table III. The following configuration is carried out by using the traditional approach, and the end result of the conventional method demonstrates the extent to which the parameters bx have an impact on the outcomes of the AP evaluation. The conventional method is successfully implemented, and then the FL Sugeno method, which incorporates the stages of the fuzzy concept (fuzzy-inference-de-fuzzy), will be implemented. The results of the FL method will be obtained, and the final result of the FL Sugeno method will demonstrate the value of the influence that the parameters ax have on the outcomes of the AP evaluation. Moreover, the computation that is used to determine the ultimate value of the Advanced Placement (AP) assessment is stated in decision value (DV), which is a kind of mathematical modeling of the AP assessment that is being investigated in this work. Lastly, the results of the Advanced Placement (AP) examination for each individual student are presented with a value range that ranges from 0 to 100.

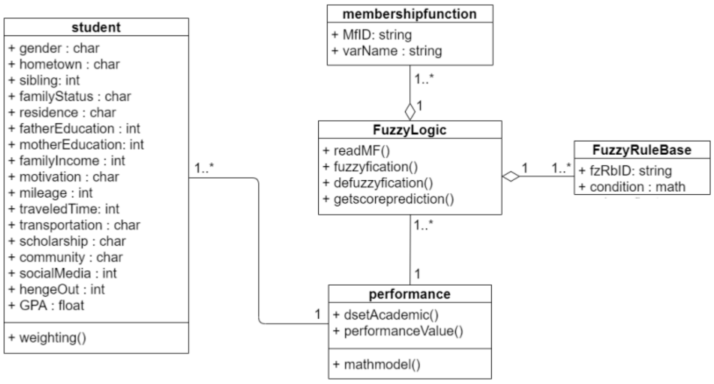

Figure 2 Class Diagram for the Constructed Model

Model's Class Diagram

The purpose of constructing a class diagram (CD) of a model is to illustrate a collection of classes, interfaces, and collaborations, as well as the connections that exist within them. Figure 3 depicts the CD of the model that is being used. Figure 3 depicts the CD that was used in the construction of the model, which was comprised of a single kind of class, namely students. It is possible to understand the CD model as follows: one student has one performance value, and performance is derived based on many FL values, with FL values created based on many membership functions and fuzzy rule bases.

Model's Process Flow

While the process of creating the model that will be utilized in real terms is being carried out, the evaluation for the Advanced Placement course is being carried out. To begin, it is essential to make preparations for the parameters that will be used in the process of building the model. A survey of the existing literature was carried out at the outset of the research project in order to collect the essential parameters. The procedure of developing the model required the gathering of as many as seventeen parameters, which were then used in the process of constructing the model. In order to move the model that is being produced closer to the truth value of the problem, the attribute value of each parameter is defined based on real facts that are occurring in the field. This is done with the intention of getting the model closer to the truth value.

Table 2 Data Samples

P1	P2	P3	P4	P5	P6	…	P12	P13	P14	P15	P16	P17
F	OT	5	L	H	1	…	PB	N	N	7	2	3.53

The processing of the sample data begins with the input parameter bx, and it continues until the processing is finished. The conventional method yields a final result of 0.36, which is obtained by multiplying the number of parameter values bx by the weight value (∑WC) of 0.1188. Because the value of ∑(bx) is the result of multiplying three by the weight value, this is the reason why this is the case. As can be seen in Table III, the results of the investigation using the usual method are presented. According to Table IV, the outcomes of the usual computations performed on each and every dataset are shown.

In order to carry out the computations for the second stage of the model calculation, the FL Sugeno approach is used. The first step of the fuzzy logic method methodology is the fuzzy stage, which is also the first stage of the idea behind the methodology. A procedure that is also known as the fuzzy stage is the process of translating the crisp (numerical) value of the input model for the parameter member into the fuzzy set and determining the value of the degree of truth. This process is carried out during the fuzzy stage.

At an early stage in the process of developing the FL approach, the MF and LV scales were developed with the idea of being used as a calculating scale. The function of LV in the concept of the FL approach is used in order to offer an explanation for the condition level of each fuzzy parameter that is the topic of academic computation. This provides an explanation for the condition level. After that, LV is produced with the use of MF in the form of a graph that illustrates the degree of membership of each input parameter value that falls within the range of 0 to 1. LV is then designed with the help of MF. It is possible to use the symbol to denote the degree to which a variable is a member of the expression. The rules use the membership value as a weighting element to evaluate the implications of the scenario. This is done in order to draw conclusions and make inferences about the situation.

Table 3 conventional method result

bx								∑WC	∑(bx)
P1	P2	P4	P5	P9	P12	P13	P14		
0	1	0	1	0	1	0	0	0.1188	0.36

Table 4 conventional method result for all data

Data	bx								∑WC	∑(bx)
	P1	P2	P4	P5	P9	P12	P13	P14		
1	0	1	1	1	0	1	1	1	0.1188	0.72
2	0	1	0	0	1	0	0	1	0.1188	0.36
…	…	…	…	…	…	…	…	…	…	…
99	0	1	0	0	0	0	0	0	0.1188	0.12
100	0	1	0	1	0	1	0	1	0.1188	0.48

To summarize, fuzzy MF is constructed by using a curve, more precisely a triangular trapezoidal curve, in order to include each and every fuzzy parameter with precision. According to the explanation that is provided below, the kind of representation of the MF for each parameter that is a part of the fuzzy parameter group is as follows: In Figure 4, the parameter of the number of siblings is divided into two distinct LVs, which are referred to as Low and High. Both of these ranges are shown in the figure. For the purpose of manually calculating the fuzzy value, equations (1) and (2) are used to extract the information that is required. From a technical point of view, each and every one of the fuzzy qualities, such as the education level of the father, the education level of the mother, the income of the family, the distance, the length of the trip, social media, going, and grade point average, were processed in the same way. With the case data that is shown in Table IV as an example. Using the FL Sugeno approach, an operation is carried out on the fuzzy process, and the input value that is included in the parameter (ax) is used in the process. The results of the fuzzy process are shown in Table V, which provides a detailed breakdown of the outcomes.

$$\mu_{Low(x)} = \begin{cases} 1; & x < 1 \\ \frac{4-x}{4-1}; & 1 \le x < 4 \\ 0; & x \ge 4 \end{cases}$$

$$\mu_{High(x)} = \begin{cases} 0; & x < 1 \\ \frac{x-1}{4-1}; & 1 \le x < 4 \\ 1; & x \ge 4 \end{cases}$$

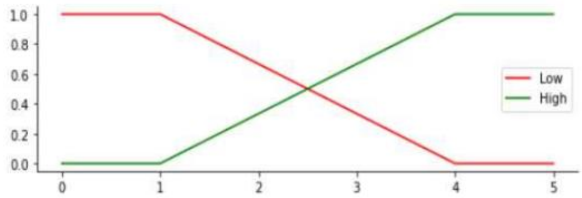

Figure 3 Membership function of parameters number of siblings

Table 5 result of fuzzy process

P3	P6	P7	P8	P10		P11		P15		P16	P17
5	1	1	500000	5		20		7		2	3.53
µ H	µ L	µ L	µ L	µ L	µ M	µ L	µ M	µ L	µ H	µ L	µ E
1.000	1.000	1.000	1.000	0.833	0.167	0.500	0.500	0.167	0.833	1.000	1.000

Within the realm of academia, fuzzy rules are known to be used for the purpose of producing output values in the form of fuzzy set values, which are derived from fuzzy input values. The value of the fuzzy process that is carried out during the inference process is used to define the fuzzy rule base. This is accomplished by the use of a collection of rules and the correlation between them, which is based on the MIN implication function. The model makes use of a total of 3,456 rule bases, with 1,728 designed to account for poor performance and 1,728 designed to account for high performance. It is dependent on the number of languages that are included inside each parameter as well as the number of parameters that are ax. It has been suggested that hazy rules have ever been in place. A matrix process is then performed against the fuzzy rules in order to find the minimum value of each rule and calculate the times value of the minimum value to the performance index (Bad has an index value of 50 and Good has an index value of 80). The fuzzy rules are then used in the subsequent process, which is to perform a matrix process against the fuzzy rules. Detailed information on the outcomes of the matrix procedure may be found in Table VI.

Table 6 Rule Matrix

No	Rule	P3	…	P17	MIN	Index

1	Rule 1732	1.00	…	1.00	1.00	80
2	Rule 1740	1.00	…	1.00	1.00	80
3	Rule 1748	1.00	…	1.00	1.00	80
4	Rule 1756	1.00	…	1.00	1.00	80
5	Rule 1780	1.00	…	1.00	1.00	80
6	Rule 1788	1.00	…	1.00	1.00	80
7	Rule 1796	1.00	…	1.00	1.00	80
8	Rule 1804	1.00	…	1.00	1.00	80

The procedure that corresponds to the FL approach is completed with the de-fuzzy process as the last step. The method known as "de-fuzzy" is used in order to achieve the goal of converting the fuzzy membership values into precise judgments or real figures. It is necessary to turn the fuzzy value back into a crisp value, which is a real number, and the fuzzy output must be changed into a crisp value in order to do this.

Through the use of the centroid strategy, which is also referred to as the center point method, this defusing operation is carried out, as seen by the equation. During this technique, the state of each fuzzy zone is taken into account, which ultimately results in the production of findings that are more accurate.

$$Z = \frac{\sum_{i=1}^{n} a_i * z_i}{\sum_{i=1}^{n} a_i}$$

Following the completion of the de-fuzzy procedure, a Z value of 80,000 is obtained. After the defuzzy process is complete, the final result, denoted by Z, is multiplied by the entire value of the fuzzy parameter weight. This allows one to calculate the total amount of the impact that the fuzzy parameter has $(\sum(ax))$ So that from the final process of the FL Sugeno method, the value $(\sum(ax))$ 70.49% will be acquired as a result. The results of the final computation using the FL Sugeno technique are shown in Table VII at this point.

Table 7 Result of Final Measurement From FL Sugeno Method

Data	Z	∑WC	∑(ax)
1	80.00	0.881	70.49
2	50.00	0.881	44.06
…	…	…	…
99	80.00	0.881	70.49
100	80.00	0.881	70.49

Table 8 Result of Decision Value (DV)

Dataset	∑(ax)	∑(bx)	DV
1	70.49	0.71	71.20
2	44.06	0.36	44.41
…	…	…	…
99	70.49	0.12	70.61
100	70.49	0.48	70.96

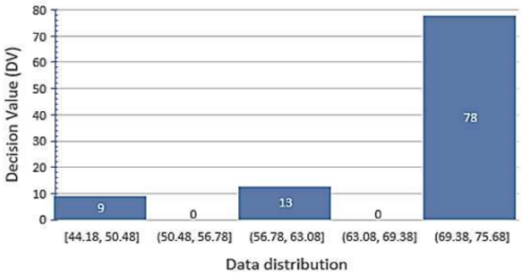

Figure 4. Data Distribution of AP Measurement

In accordance with the DSM-AP paradigm, the last step of the AP evaluation is successfully completed. The AP evaluation is created in the form of DV by a calculation procedure that compares the outcomes of the computation of both the traditional (bx) and the FL Sugeno (ax) approaches. DV equals 70.49 plus 0.36, which is 70.85, as stated in the calculation details.

The findings of the AP assessment (DV) of 70.85 are derived from the range of values that vary from 0 to 100. These results are acquired from the case input that is computed based on the DSM-AP model and are shown in Table 4.5. As a consequence of the performance outcomes, the value of 70.85 indicates that the value of 70.85 is obtained as a result. In order to get a performance appraisal, 17 criteria are taken into consideration as subjective values. These parameters have the potential to influence the outcomes of academic performance appraisal judgments, which are more robust than the normal grade point average evaluation since they include a variety of characteristics to be examined. TABLE VIII displays the information that was obtained from the final computation of the model that was used to produce DV.

It is possible to construct a distribution of data from the AP assessment by using the final calculation results of the assessment. A representation of the outcomes of the data distribution may be seen in Figure 5. Meanwhile, the study that was carried out was used to determine the influence value for each parameter. This value was derived from the weight values that were shown in Table IX. The graph in Figure 5 illustrates the percentage of the parameters that have an impact on the parameter values. The weight value for the effect of each parameter is ranked from highest to lowest, with the highest weight value being the grade point average (GPA) and the lowest being the location of residence.

Conclusion

The study demonstrates that a fuzzy decision support model is capable of properly predicting the academic progress of students by integrating quantitative and qualitative data. Because it is able to manage subjective, imprecise, and ambiguous data, the fuzzy logic-based technique is well-suited to real-world educational settings. This is because, in contrast to traditional models, it is able to handle data that is subjective, imprecise, and complex, such as the degree of engagement, motivation, and socio-economic circumstances. For the purpose of better preparing for lessons, identifying students who are at risk of falling behind, and providing more focused help, educators may use the model's simple and customisable framework for evaluating student performance in the classroom. When taken as a whole, this work demonstrates that fuzzy logic has the potential to be an excellent instrument for the development of intelligent educational systems. Furthermore, it paves the way for future research that will integrate fuzzy logic with machine learning in order to develop hybrid models that have even higher levels of prediction accuracy and decision support.

Reference

1. Salal, Y. K., Abdullaev, S., and Kumar, M. 2019. Educational Data Mining: Student Performance Prediction in Academic. International Journal of Engineering and Advanced Technology (IJEAT), 8(4C), 54-59.

2. Kumar, A. D., Pandi, R. S., and Palanisamy, V. 2019. Prediction of Student Performance using Hybrid Classification. International Journal of Recent Technology and Engineering (IJRTE), 8(4), 6566- 6670.

3. Cavallaro, F. 2015. A Takagi-Sugeno Fuzzy Inference System for Developing a Sustainability Index of Biomass. (M. Rosen, Ed.) Sustainability, 7(9), 12359-12371.

4. Atanassov, K.T., “Intuitionistic fuzzy sets”, Fuzzy Sets and Systems, Elsevier Science Publications, Vol. 20, No. 1, pp. 87-96, (1986).

5. Banerjee, S., and Roy, T.K., “Arithmetic Operations on Generalized Trapezoidal Fuzzy Number and its Applications”, Turkish Journal of Fuzzy Systems, Vol. 3, No. 1, pp. 16- 44, ISSN: 1309-1190, (2012).

6. Bansal, A., “Trapezoidal Fuzzy numbers (a,b,c,d): Arithmetic Behavior”, International Journal of Physical and Mathematical Sciences, pp. 39 - 44, ISSN: 2010-1791, (2011).

7. Bekheet, S., “Polygon Fuzzy Numbers”, Africa Development and Resources Research Institute Journal, Vol. 3, No. 3, pp. 52-63, (2013).

8. Black, M., “Reasoning with Loose Concepts”, Dialogue, Vol. 2, pp. 1-12, (1963).

9. Dijkman, J.G., Haeringen, H. van., and Lange, S.J. de., “Fuzzy Numbers”, Journal of Mathematical Analysis and Applications, Vol. 92, No. 2, pp. 301-341, (1983).

10. Dubois, D., and Prade, H., "Operations on Fuzzy Numbers", International Journal of System Sciences, Vol. 9, pp. 613-626, (1978).

11. Gani, A.N., and Assarudeen, A.N.M., "A New Operation on Triangular Fuzzy number for Solving Fuzzy linear Programming Problem", Applied Mathematical Sciences, Vol. 6, No. 11, pp. 525-532, (2012).

12. Hanss, M., "Applied Fuzzy Arithmetic: An Introduction with Engineering Applications", Springer – Verlag Berlin Heidelberg, ISBN 978-81-8489-300-7, (2005).

13. Helen, R., and Uma, G., "A New Operation and Ranking on Pentagon Fuzzy Number", International Journal of Mathematical Sciences and Applications, Vol. 5, No. 2, pp. 341- 346, (2015).

14. Hellendoorn, H., "Fuzzy Numbers and Approximate Reasoning", Annales Univ. Sci. Budapest., Sect. Comp, Vol. 12, pp. 113-119, (1991).

15. Jain, R., "A Procedure for Multiple-aspect Decision using Fuzzy Sets", International Journal of System Sciences, Vol. 8, pp. 1-7, (1977).

16. Jain, R., "Tolerance Analysis Using Fuzzy Sets", International Journal of System Sciences, Vol. 7, pp. 1393-1401, (1976).

17. McCahon, C.S., and Lee, E.S., "Comparing Fuzzy Numbers: The Proportion of the Optimum Method", International Journal of Approximate Reasoning, Vol. 4, pp. 159-181, (1990).

18. Mendel, J.M., and John, R.I.B., "Type-2 Fuzzy Sets Made Simple", IEEE Transactions on Fuzzy Systems, Vol. 10, No. 2, pp. 117-127, (2002).

19. Mendel, J.M., and John, R.I.B., and Liu, F., "Interval Type-2 Fuzzy Logic Systems Made Simple", IEEE Transactions on Fuzzy Systems, Vol. 14, No. 6, pp. 808-821, (2006).

20. Miyamoto, S., "Fuzzy Multisets and Their Generalizations, Multiset Processing", Series of Lecture Notes in Computer Science, Springer-Verlag Publishers, Vol. 2235, pp. 225- 235, (2001).

21. Miyamoto, S., "Multisets and Fuzzy Multisets", Soft Computing and Human-Centered Machines", Springer Publisher, pp. 9-33, (2000).