

Evaluation of Student Performance Using Fuzzy Logic

Sanjana Naidu Gedela¹, Pavan Bodanki²

¹Computer Science and Engineering Student at Vignan's Institute of Information Technology Duvvada,
(Visakhapatnam)

²Electronics and Communication Engineering Student at SRKR Engineering College Bhimavaram, India.

-----***-----

ABSTRACT: This Project Presents a Fuzzy Logic based approach for student performance evaluation in colleges. The parameters to consider for evaluation were academic performance, and extra-curricular activities to analyze the student performance for future evaluation. In our proposed approach, we work on three domains - placement, result evaluation and higher study field for a student. This study helps the educational institutes how to enhance their current evaluation techniques for better evaluation.

Index:

Introduction, Literature, Algorithm, System design, Usecase diagram, Implementation, Results, Code, Conclusion, References

1.Introduction:

Assessment assists with building an instructive program, evaluate and enhance one's accomplishments and viabilities. It fills in as an in-assembled screen inside the program to survey the advancement in gaining every now and then. It additionally gives important criticism on the structure and the execution of the program. Hence, assessment assumes a critical job in any instructive program.

It provides accountability to the society, parents, and to the education system. Education system plays an important role for the betterment of the nation. Quality factor of educational institutions are backbone of social development. Quality factor of a particular institution is only determined by the student performance in various fields. Our work focuses on semester marks, placements and higher studies. Semester marks module takes students previous semester marks and gives the expected result of next semester. Placement module takes the input data like mock interview scores, core knowledge, academic score and gives the percentage of how much he can succeed in the campus placement interview. Higher studies module takes input like student's mock exam scores, management skills, communication skills and evaluates which field will be better for the student if he wants to pursue higher education.

This system proposes the use of fuzzy logic techniques and fuzzy inference system approach for the evaluation of students. Fuzzy logic helps more reliable decision making and evaluation of applications using a predetermined list of criteria.

1.1Motivation

Every college needs a concrete evaluation strategy to evaluate a student performance. If the evaluation process is eliminated from human life then perhaps the aim of life may be lost. The main motive behind this project is to evaluate students and help them in their growth. Evaluation must be a continuous process for the growth of a student. Specifically, this fuzzy model is used to emulate human reasoning approach for the evaluation of student.

1.2 Purpose

The main purpose of this project is to evaluate students with a reasoning system similar to human reasoning system. Evaluation is the primary step for the growth of the student. Evaluation is useful in measuring the progress of the student. Fuzzy logic is used in this evaluation process because it is similar to human reasoning system. This project is used by educational institutions, which can prepare a plan of action for the student based on these evaluation result.

2. Literature survey:

2.1 Problem Definition

To develop a acceptable reasoning approach which imitates human reasoning to evaluate a student performance in various fields based on the students previous performances to take necessary actions by the institution to improve student performance.

2.2 Existing System

The existing system developed using the fuzzy toolbox in MATLAB used fewer input parameters for evaluation process. The reasoning process of this system is better than traditional methods like average method but the results of this system are not completely enough to evaluate a student. The executable of the proposed system does not work on systems which do not have MATLAB(or MATLAB component run time(MCR)). The existing system also did not had any mechanisms to handle exceptions.

2.3 Proposed System

Proposed model works on evaluation of student in various aspects of his academics for all-round improvement. This model aims to improve the reasoning approach by taking more input parameters into consideration unlike the existing system. The maxima defuzzification methods(first of maxima, mean of maxima, last of maxima) used here are suitable for reasoning approach. To find the best input parameters that affect the output variable, Pearson correlation coefficient was calculated for every input parameter with respect to the output parameter. If the Pearson correlation coefficient a input variable with respect to output variable is close to 1, it means that input variable is closely effecting the output variable or both variables change in one direction.

3. Algorithm

3.1 Pearson Correlation

Coefficient Pearson Correlation coefficient is used to measure the linear correlation or relationship between two variables x,y and it also gives the direction of relationship. It has a value between -1 and +1. This is applied on each of the input variable with respect to the output variable to know the strength of the relationship. The input variables which are highly correlated with output variable are taken into consideration while developing these model. The formula for finding Pearson correlation is

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}}$$

3.2 Fuzzy Logic

Fuzzy generally means unclear. Fuzzy logic (FL) is a form of multi valued logic where the truth values lies between 0 and 1. Fuzzy logic starts with the concept of a fuzzy set. A fuzzy set is a set without a crisp, clearly defined boundary. It can contain elements with only a partial degree of membership. In fuzzy logic, the truth of any statement becomes a matter of degree. To understand what a fuzzy set is, first consider the definition of a classical set. In classical set, an element either belongs (yes) or does not belong to the set (no). In fuzzy logic, an element belongs to a set with some aid of a membership value.

Consider the example of a describing the temperature of a day. In classical set theory, it is described as {cold, hot}. But in fuzzy set theory, the vague values can also be represented like {very cold, cold, somewhat hot, very hot}. FL may be viewed as a methodology for computing with words rather than numbers. Although words are inherently less precise than numbers, their use is closer to human intuition. By using fuzzy logic, we can consider the inaccuracies and uncertainties of any situation. For a finite set $U = \{x_1, x_2, \dots, x_n\}$, the fuzzy set (U, m) is denoted by $\{m(x_1)/x_1, m(x_2)/x_2, \dots, m(x_n)/x_n\}$ Let x belongs to U , then x is Not included in the fuzzy set if $m(x) = 0$ (not a member) Fully included in the fuzzy set if $m(x) = 1$ (full member) Partially included in the fuzzy set if $0 < m(x) < 1$ (fuzzy member)

3.2.1 Fuzzy Inference System(FIS)

Fuzzy inference system(FIS) is the primary unit of fuzzy logic having decision making as its primary work. It uses IF..THEN rules and connectors like OR,AND for making decisions. Based on the type of IF..THEN rule the different types of inference systems are,

1. Mamdani FIS

This system was proposed in 1975 by Ebhasim Mamdani. The rule format of mamdani FIS is If x is A and y is B the z is C , where A,B,C are fuzzy values. The output of a mamdani FIS is always a fuzzy value. It can be converted into crisp value using a process called defuzzification. Mamdani FIS is more suited to human input. Mamdani FIS is used in designing this model.

Functional block of Mamdani FIS Mamdani Fuzzy Inference System comprises of 3 steps

- a. Fuzzification - converting crisp inputs into fuzzy inputs.
- b. Rule Base - applying rules to the fuzzy inputs to get a fuzzy output.
- c. Defuzzification - converting fuzzy output to a crisp output.

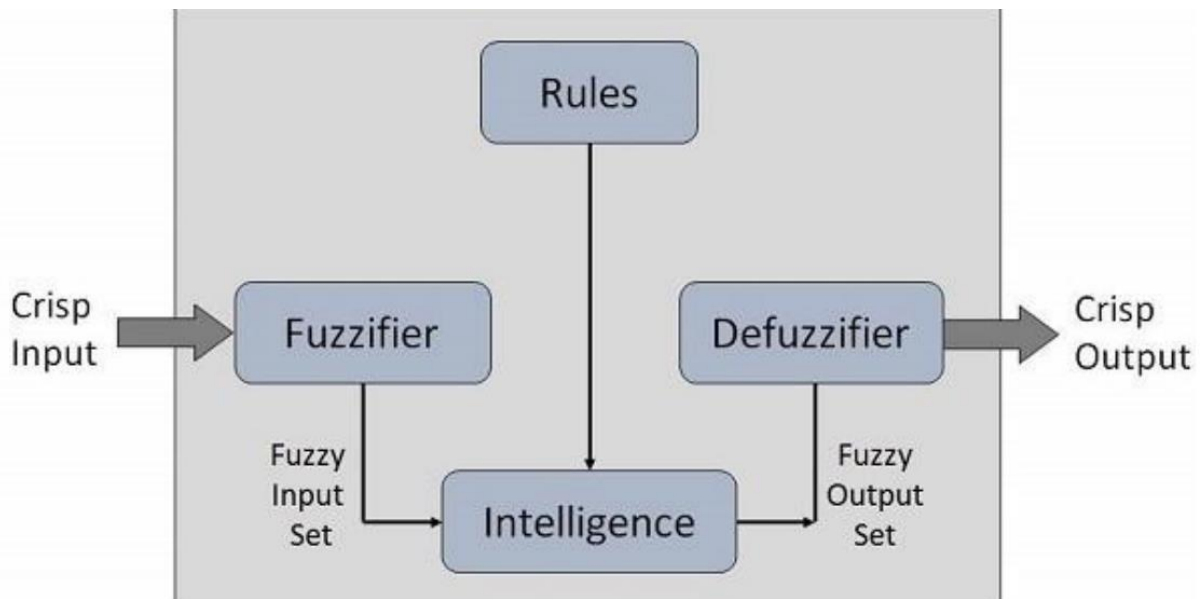


Fig 3.3.2 Mamdani Fuzzy Inference System

a.Fuzzification

In this step, the inputs(crisp values) are converted into fuzzy values. Crisp inputs are basically the exact inputs. Crisp values are also defined as the exact measurement of a variable. This conversion is performed using the membership functions.

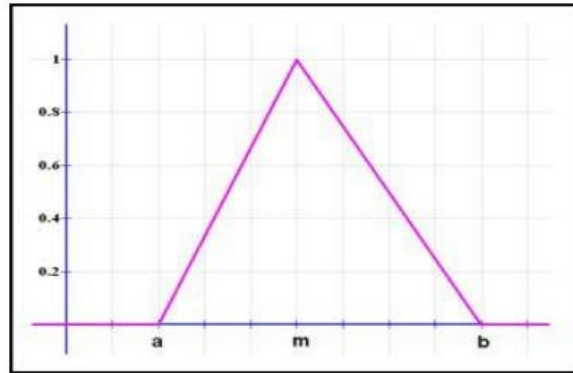
Types of membership functions(MF)

The most common membership functions are

Triangular MF

It is the most common and simplest membership function A triangular MF is specified by 3 parameters {a,m,b} as follows

$$\mu_A(x) = \begin{cases} 0, & x \leq a \\ \frac{x-a}{m-a}, & a < x \leq m \\ \frac{b-x}{b-m}, & m < x < b \\ 0, & x \geq b \end{cases}$$



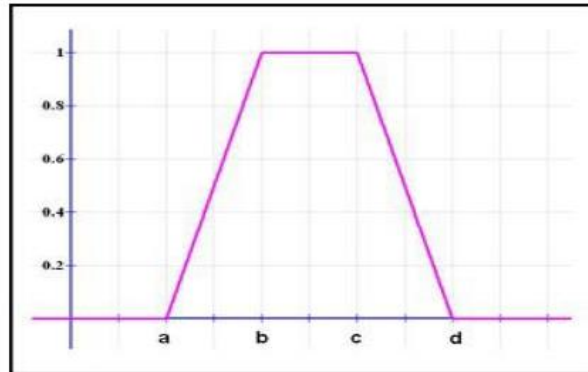
The parameters {a, m, b} (with a < m < b) determine the x coordinates of the three corners of the underlying triangular MF where m is the peak of the triangle and a, b are lower and upper limits respectively. The Y coordinates are the membership values which ranges from 0 to 1. The following statement is used for converting student's semester marks to a fuzzy value(low) using triangular membership function.

```
sem_1_low = fuzz.trimf(sem_1, [0, 0, 40])
```

Trapezoidal MF

A trapezoidal MF is specified by 4 parameters {a,b,c,d} as follows

$$\mu_A(x) = \begin{cases} 0, & (x < a) \text{ or } (x > d) \\ \frac{x-a}{b-a}, & a \leq x \leq b \\ 1, & b \leq x \leq c \\ \frac{d-x}{d-c}, & c \leq x \leq d \end{cases}$$



The parameters {a, b, c, d} is defined by a lower limit a, an upper limit d, a lower support limit, and an upper support limit c, where a < b < c < d. The following statement is is used for converting student's semester marks to a fuzzy

value(medium) using trapezoidal membership function.

```
sem_2_med = fuzz.trapmf(sem_2,[40, 45, 55, 65])
```

Gaussian MF

Gaussian MF is defined by a central value m and a standard deviation k > 0.

b. Rule Base

$$\mu_A(x) = e^{-\frac{(x-m)^2}{2k^2}}$$

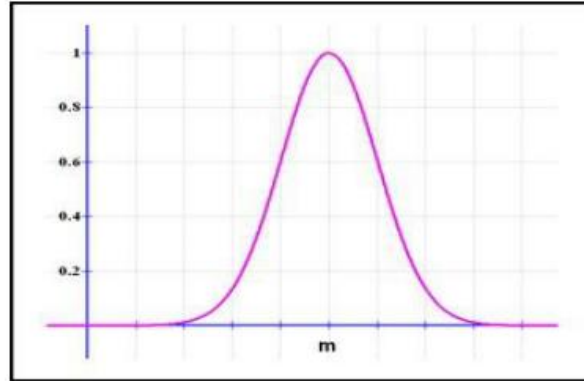


Fig 3.3.2.3 Gaussian Membership Function

If k becomes small, the bell will become narrow.

Rule base consists of IF.. THEN rules to formulate the conditional statements that comprise fuzzy logic. A single fuzzy rule can be represented as follows If x is A then y is B Where A,B are fuzzy sets and x,y are input and output variables respectively. The first part of the rule is called antecedent and the later part is called consequent. The antecedent of a rule can have many conditions combined with fuzzy operators. If sem1_marks are good AND sem2_marks are good then sem3_marks are good.

Fuzzy operators

The Fuzzy logic operators are the superset of standard Boolean logic operators. There are 3 fuzzy logic operators

- AND Operator
- OR Operator
- NOT Operator

AND Operator

Fuzzy AND operator is related to the minimum value. If the input membership values are 0.6 and 0.8 then the firing strength of fuzzy AND will be 0.6

A	B	min(A,B)
0	0	0
0	1	0
1	0	0
1	1	1

AND

OR Operator

Fuzzy OR operator is related to the maximum value. If the input membership values are 0.6 and 0.8 then the firing strength of fuzzy

A	B	max(A,B)
0	0	0
0	1	1
1	0	1
1	1	1

OR

NOT Operator

Fuzzy NOT operator is similar to the complement operator in Boolean logic. It is represented as $NOT(X) = 1 - X$

A	not A
0	1
1	0

NOT

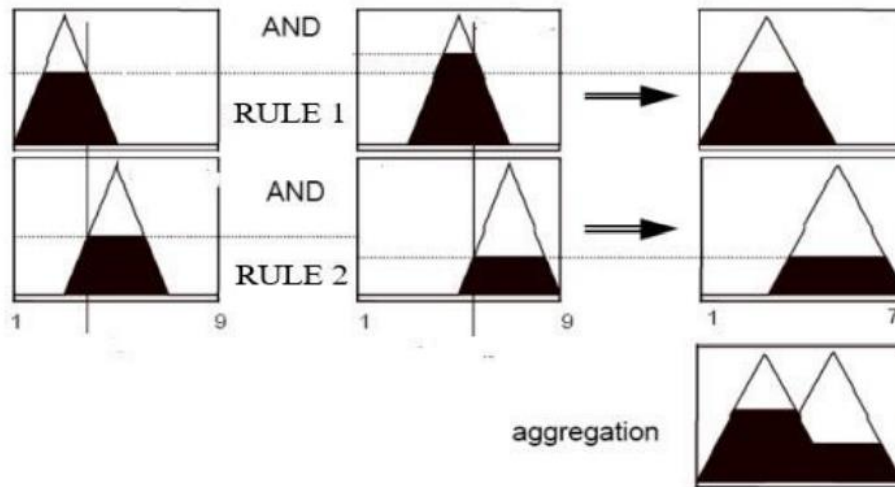
c. Defuzzification

It is the process of converting fuzzy outputs into crisp outputs (specifically numeric outputs). In detail it comprises of 2 steps

- Aggregation step
- Defuzzification step

Aggregation step

Aggregation is the process by which fuzzy sets that represent the output of each rule are combined into a single fuzzy set. Aggregation occurs only once for each output variable. It is performed before the defuzzification step

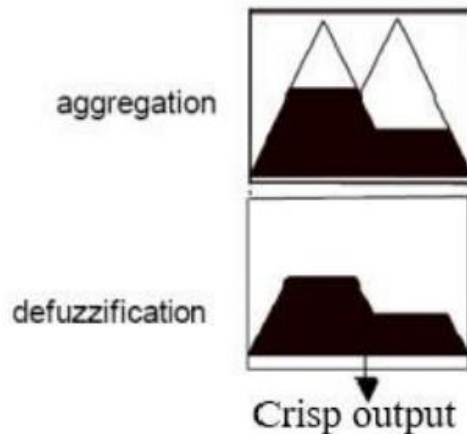


Defuzzification step

The input for the defuzzification step is the aggregate output fuzzy set and the output is a single value (crisp output). The aggregate of a fuzzy set contains a range of output values, so it must be defuzzified to obtain a single output value from the fuzzy set. There are several defuzzification methods available, some of them are

- Centroid method
- Bisector of area
- First of maxima (FOM)
- mean of maxima (MOM)
- Last of maxima (LOM)

Centroid is the most common defuzzification method and the maxima methods (FOM, MOM, LOM) are suitable for reasoning systems.



To get the crisp output, the defuzzification methods will be applied to the aggregated area as shown in the above fig

4. SYSTEM DESIGN

4.1 Input Design

Input Design plays a vital role in the life cycle of software development, it requires very careful attention of developers. The input design is to feed data to the application as accurate as possible. So inputs are supposed to be designed effectively so that the errors occurring while feeding are minimized. According to Software Engineering Concepts, the input forms or screens are designed to provide to have a validation control over the input limit, range and other related validations. This system has input

screens for all the modules. Error messages are developed to alert the user whenever he commits some mistakes and guides him in the right way so that invalid entries are not made. Let us see deeply about this under module design. Input design is the process of converting the user created input into a computer-based format. The goal of the input design is to make the data entry logical and free from errors. The error in the input are controlled by the input design. The application has been developed in user[1]friendly manner. Validations are required for each data entered. Whenever a user enters an erroneous data, error message is displayed so that the user can enter the appropriate data.

4.2 Output Design

The Output from the computer is required to mainly create an efficient method of communication within the company primarily among the project leader and his team members, in other words, the administrator and the clients. The application starts running when it is executed for the first time. The project will run on the local machine. The developed system is highly user friendly and can be easily understood by anyone using it even for the first time.

4.3 Modules

Our student performance evaluation model consists of 3 modules

Placement module

Result evaluation module

Higher studies module

Placement module

Many students dream of getting placed in a well established organization. Getting placed in an organization takes much more than the academics. To perform well in a interview, student must be well acquainted with the basics of his stream, must have some decent communication skills and a decent academic score which will act as a cut off to enter into the interview process. This placement module deals with the performance of a student in a campus placement interview. The output of this module is the percentage of his performance in the final interview process. To evaluate this, there can be many input parameters that has to be considered. We calculated pearson correlation coefficients for each input variable with the output variable in the dataset and selected the parameters whose correlation coefficients are greater than 0.7 (highly correlated values). Pearson correlation coefficients describe the relationship between two variables ranging from 0 to 1 (0-not correlated, 1-highly correlated). The input parameters that are highly correlated are students academic marks, communication skills, technical knowledge, backlogs.

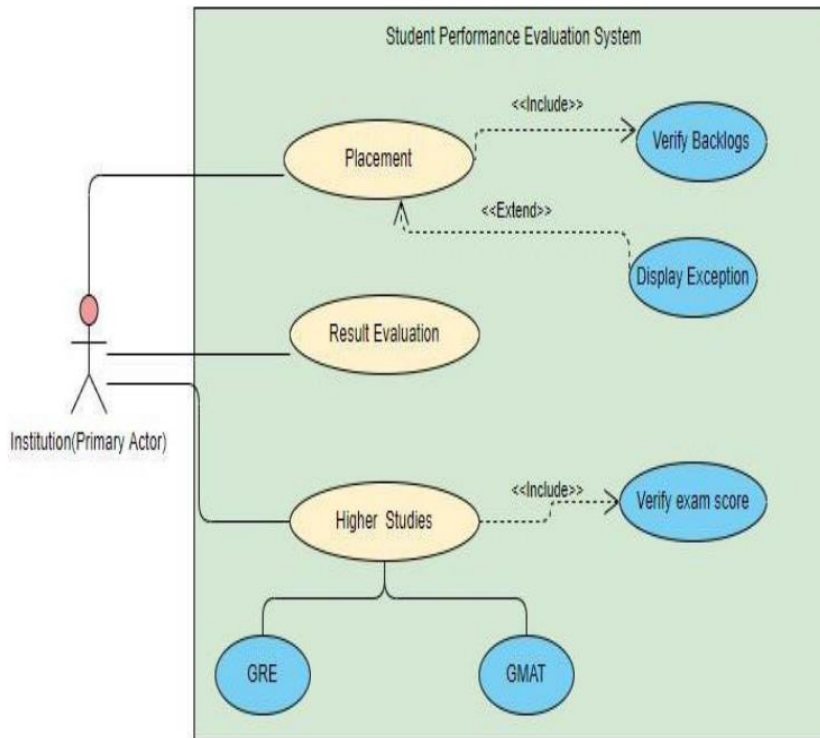
Result evaluation

Academic marks play a important role throughout the education process of a student. It is the primary factor for assessing a student at any point in his education. Good scores can make a student feel positive about himself. Good scores can also lead to scholarships. While recruiting students, students with academic score greater than the cut off set by the organization are allowed to participate in the recruiting process. So, it is always preferred to have a eye on students academic score. Our result evaluation module takes the first 6 semester marks as the input and outputs the expected next semester marks. Based on the result of this module, the college management can take necessary actions towards the students grade for the next semester.

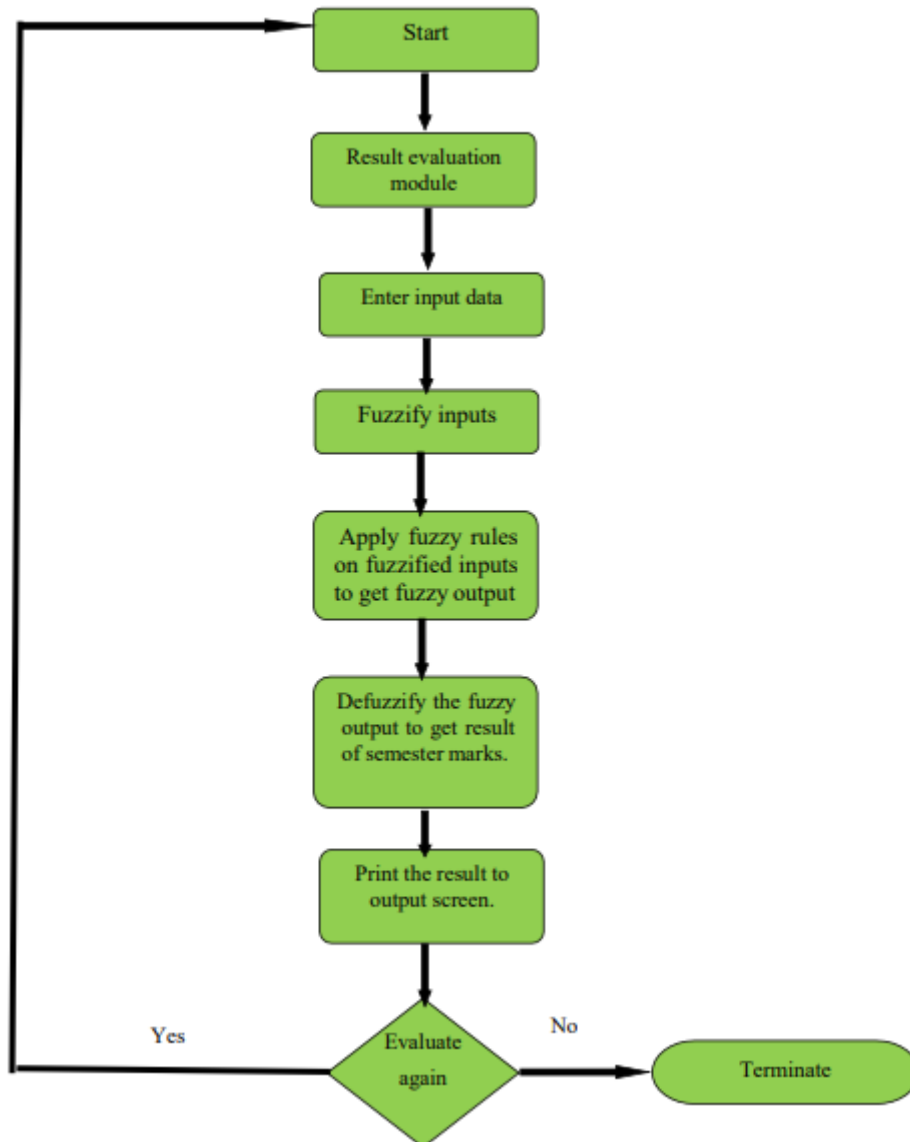
Higher Studies

After engineering, higher studies is one of the career option for students besides a job. Some of the possible options are M.S, MBA. If student want to pursue M.S from abroad then the student has to perform well in GRE exam as most college requires GRE score for application process. If any candidate wants to improve his business skills then he can pursue MBA by taking exams like GMAT. This module takes into account of all mock test exam scores attended by the candidate and also his communication skills, technical skills, management skills for better evaluation. This module returns the expected score of the candidate in his desired examination. There are many websites that predict the scores based on the mock test results but this module also takes the previous data which gives a better reasoning approach.

5. Use case diagram



6. Implementation

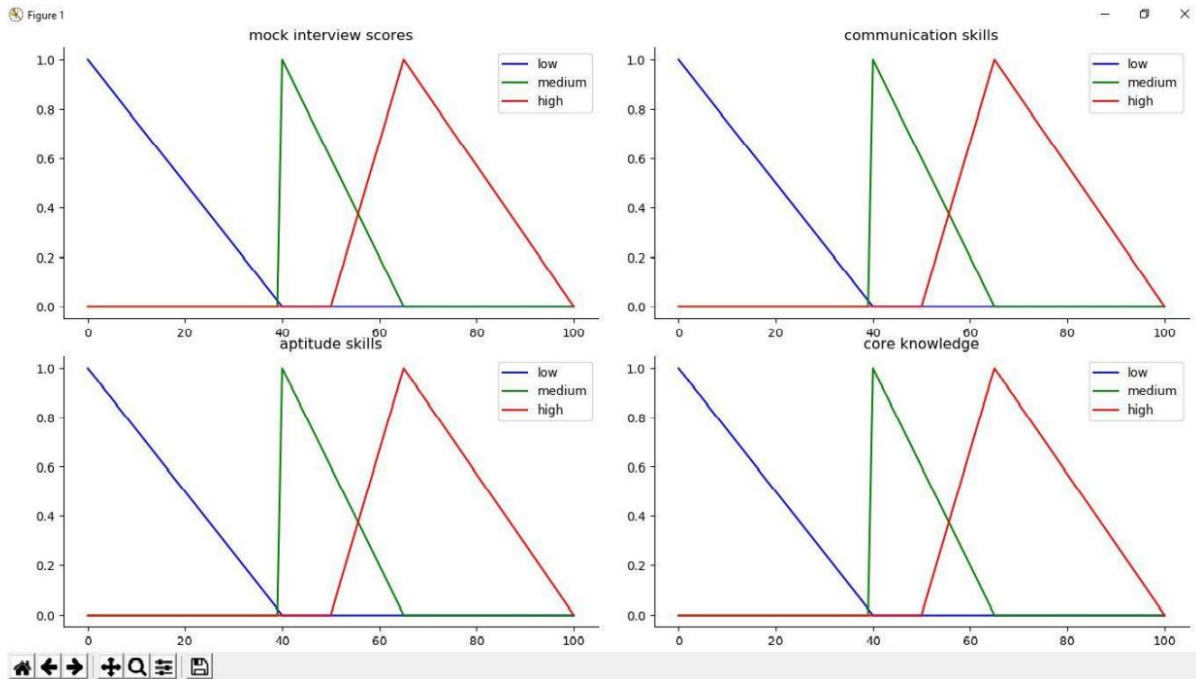


7. Result:

7.1 Placement output Screens

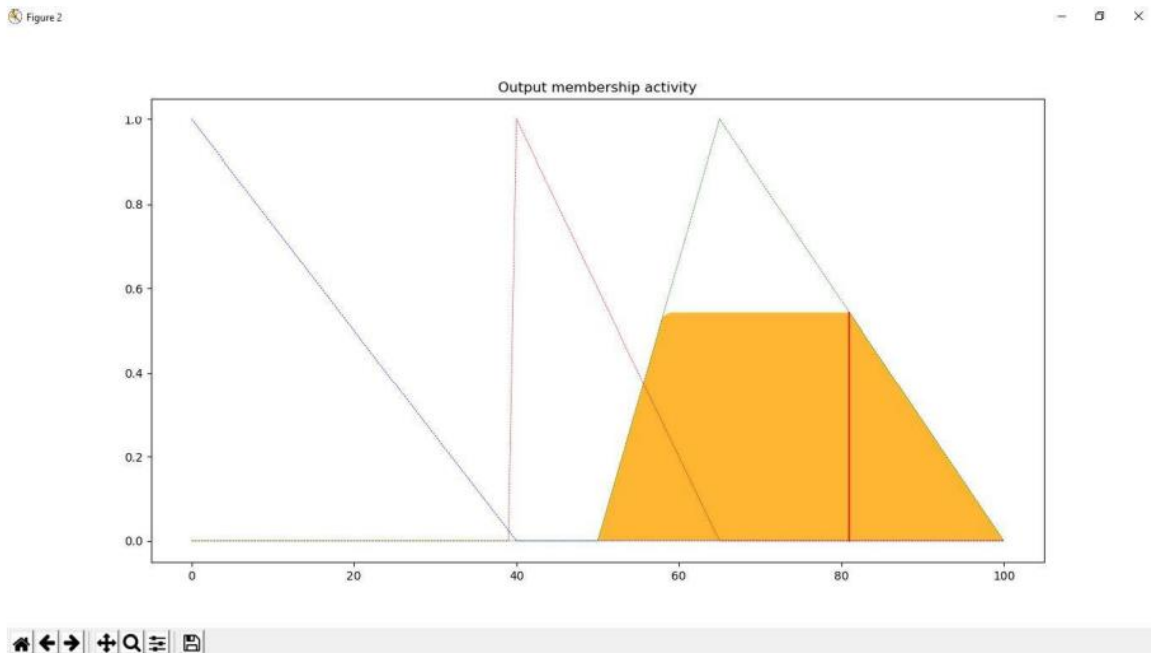
7.1.1 Placement Module input range plot

These are the input ranges for the input parameters taken



7.1.2 Output Membership Activity Plot

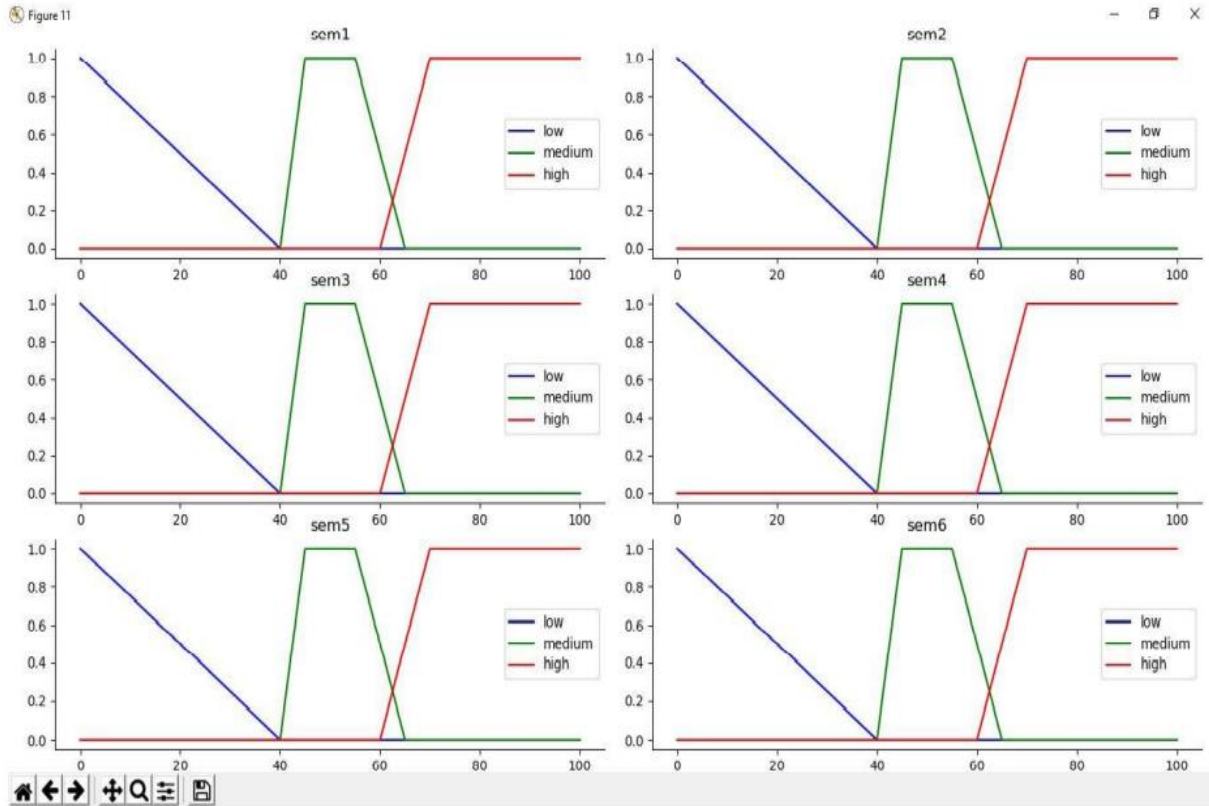
For the above input, the output membership activity is plotted here. The red line indicates the output (defuzzified value)



7.2 Result Evaluation Output Screen

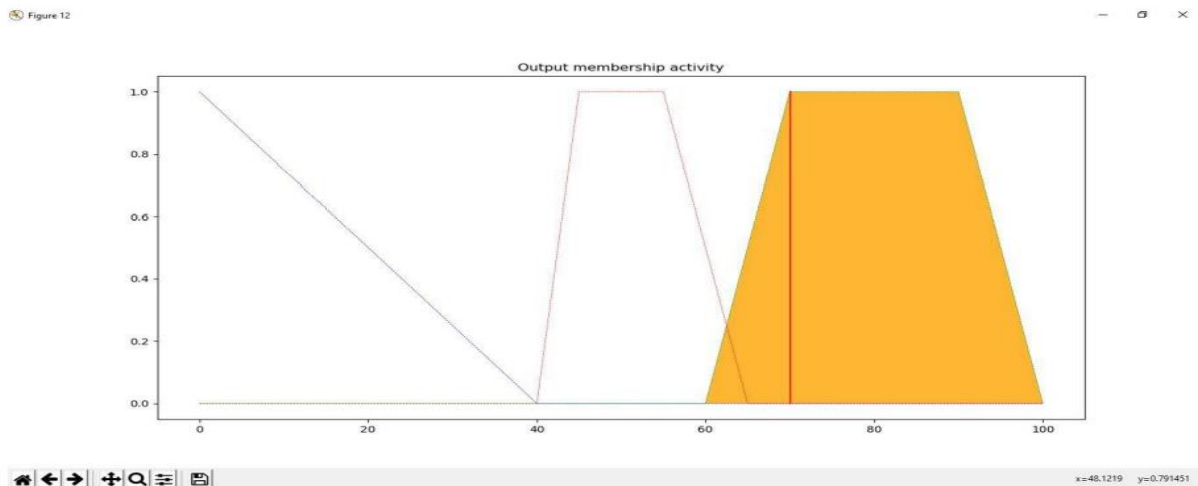
7.2.1 Result Evaluation Input Range plot

These are the input ranges for the input parameters taken in Result evaluation mode



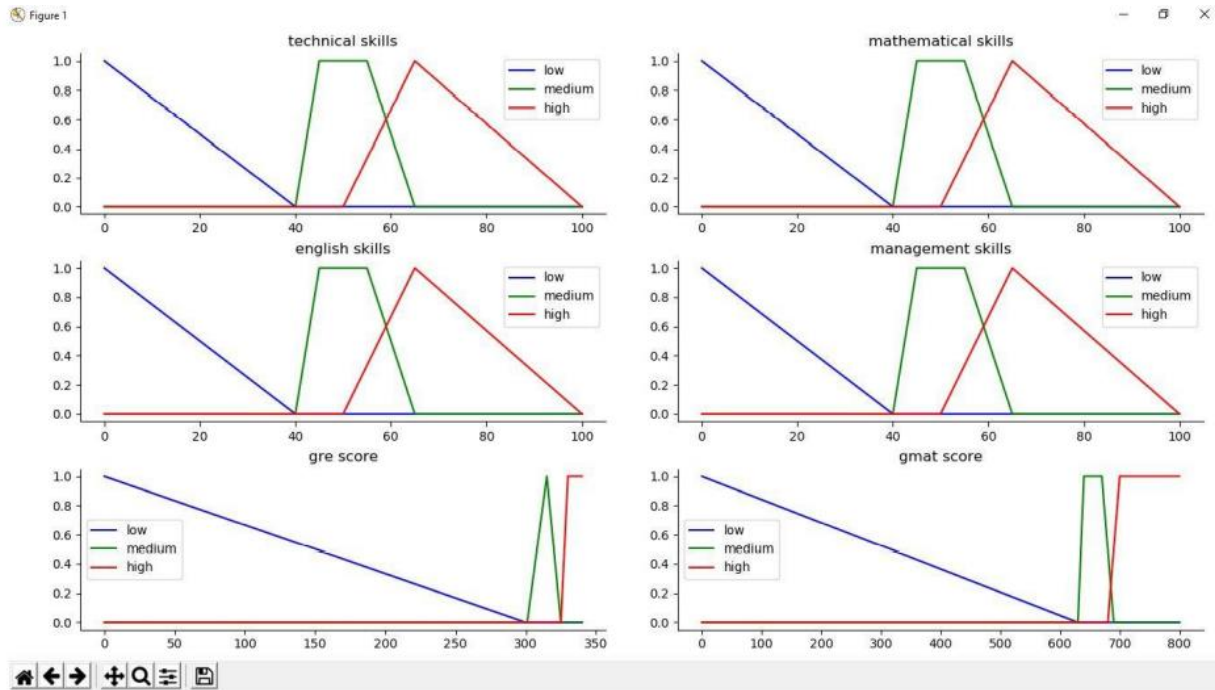
7.2.2 Output Membership activity for Result Evaluation

For the above input, the output membership activity plot is shown here. The red line indicates the output(defuzzified value)



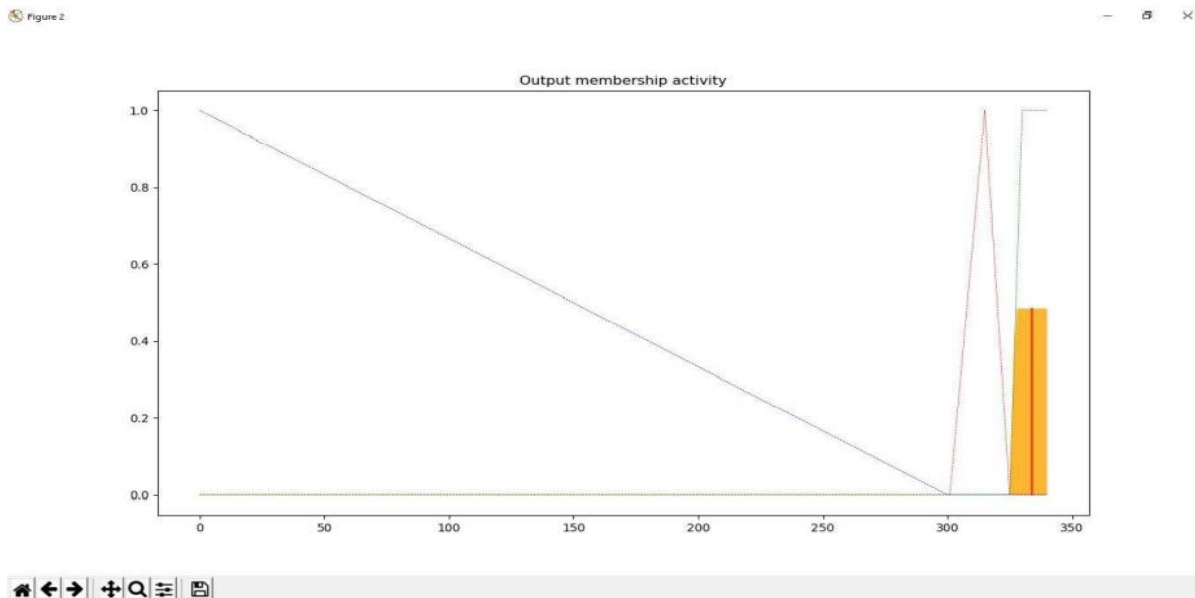
7.3 Higher Studies Input Range Plot

These are the input ranges for the input parameters taken in Higher studies



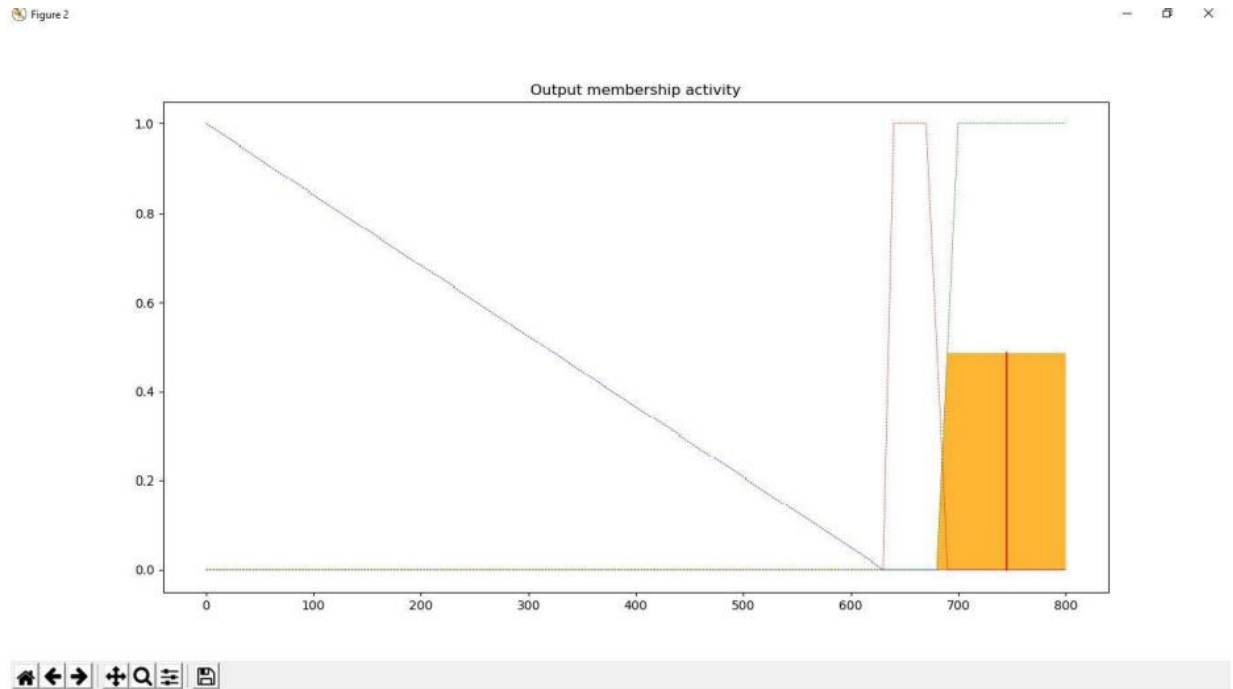
7.3.1 Output Membership activity for GRE

For the above input, the output membership activity plot of gre score is shown here. The red line indicates the output(defuzzified value).



7.3.2 Output Membership Activity for GMAT

For the above input, the output membership activity plot of gmat score is shown here. The red line indicates the output(defuzzified value)



8. Code: <https://github.com/pavanbodanki/fuzzy-logic/tree/main>

9. CONCLUSION

This paper proposes a system to evaluate students performance in placement, result evaluation, higher studies using fuzzy logic approach. The introduction of fuzzy logic makes our model capable to mimic human reasoning approach into our system. The proposed approach is based on three modules - Placement, Result Evaluation, Higher Studies that are used for evaluating the student performance which specify that what is the current status of student performance and how much improvement is needed and what is best for them in future is obtained. The important factor in fuzzy logic is selecting the suitable fuzzification and defuzzification methods. In our scenario, the methods which are suitable to reasoning approach are used.

10. REFERENCES

- [1] Maria Samarakou, Pantilis Prentakis, "Application of fuzzy logic for assesment of Engineering students", IEEE Global Engineering Education Conference (EDUCON), 2017.
- [2] V. Anurag Rao, Jageshwer Shriwas , S R Tandan , Shaguffta Farzana , "Enchanced Academic Performance Evaluation Technique Using Fuzzy System.", International Journal for Research in Applied Science & Engineering Technology(IJRASET),2016.
- [3] Ashwani Kharola, Swarnima Kunwar, Gopa B Choudhury, " Students Performance Evaluation: A fuzzy logic reasoning approach" ,PM World Journal, 2015.
- [4] Zehra Yıldız, Fevzi Baba, "Evaluation of Student Performance in Laboratory Applications using Fuzzy Decision Support SystemModel", IEEE Global Engineering Education Conference (EDUCON),2014.

[5] SuvarnaPatil, Ayesha Mulla R.R. Mudholkar, "Best Student Award – A Fuzzy Evaluation Approach", International Journal of Computer Science and Communication, 2012..

[6] Arshdeep Kaur, Amrit Kaur , " Comparison of Mamdani-Type and Sugeno-Type Fuzzy Inference Systems for Air-conditioning .