Fuzzy-Based Recommendation System for FYP Research Area Selection

Thilini Deshika (E/16/078), Sudam Kalpage (E/16/168), Hashan Eranga (E/16/275), Rusiru Thushara (E/16/369)
Department of Computer Engineering, Faculty of Engineering, University of Peradeniya

I. INTRODUCTION

Final Year Projects (FYP) are a mandatory part of the university students' curriculum where they get the opportunity to demonstrate what they have learnt. There, selecting a suitable Research Area (RA) is important for a student to perform well in their FYP. The solution presented here is a fuzzy logic based RA recommendation system which is able to provide suggestions for the RAs that closely match with a student's skills and interests.

II. PROBLEM STATEMENT

With the diversity of RAs, students need the assistance of their advisors or experienced persons on the considered RA, to get an idea about the RA before selecting it to proceed with their FYP. Students may have to face issues when following this procedure due to time limitations and availability of resource persons. Sometimes, the decided RA of students can be biased depending on outside factors such as resource persons' desires and personal opinion. When selecting the RA, students may also have to experience uncertainties due to the similarities between RAs.

The proposed solution aims to minimize the uncertainty and bias of a student's decision on selecting an RA. The fuzzy based recommendation system suggests suitable RAs for the student, depending on the skills and interests of the student and scope of the RA. This will help the student to continue with the research area applying their skills effectively.

III. METHODOLOGY

A. Inputs and Outputs to the Fuzzy System

Below mentioned are the RAs considered for the fuzzy system.

- Machine Learning and Big Data
- Network Security
- Cloud Computing
- Embedded Systems
- Computer Networking

Students will be matched to considered RAs depending on the following skills.

- Statistics and Maths
- Analytical Skills
- Problem-Solving Skills
- Communication Protocols Skills
- Database Management
- System Designing
- Implementation
- Algorithmic Skills

TABLE I
LINGUISTIC VARIABLES

Type	Linguistic Variable	Linguistic Value
Input	Statistics and Math Analytical Skills Problem-Solving Skills Communication Protocols Skills Database Management System Designing Implementation Algorithmic Skills	High Medium Low
Output	Machine Learning and Big Data Network Security Cloud Computing Embedded Systems Computer Networking	High Medium Low

B. Rule Base

Rule Base for each output will be as follows.

Embedded Systems

1) If (System Designing skills is low) and (Implementation skills is low) then (Embedded systems is low)
2) If (System Designing skills is low) and (Implementation skills is medium) then (Embedded systems is low)
3) If (System Designing skills is low) and (Implementation skills is high) then (Embedded systems is medium)
4) If (System Designing skills is medium) and (Implementation skills is low) then (Embedded systems is low)
5) If (System Designing skills is medium) and (Implementation skills is medium) then (Embedded systems is medium)
6) If (System Designing skills is medium) and (Implementation skills is high) then (Embedded systems is high)
7) If (System Designing skills is high) and (Implementation skills is low) then (Embedded systems is medium)
8) If (System Designing skills is high) and (Implementation skills is medium) then (Embedded systems is high)
9) If (System Designing skills is high) and (Implementation skills is high) then (Embedded systems is high

Network Security

1) If (Analytical skills is low) and (Communication skills is low) and (Algorithmic Skills is low) then (Computer Networking is low)
2) If (Analytical skills is low) and (Communication skills is low) and (Algorithmic Skills is medium) then (Computer Networking is low)
3) If (Analytical skills is low) and (Communication skills is low) and (Algorithmic Skills is high) then (Computer Networking is medium)
4) If (Analytical skills is low) and (Communication skills is medium) and (Algorithmic Skills is low) then (Computer Networking is medium)
5) If (Analytical skills is low) and (Communication skills is medium) and (Algorithmic Skills is medium) then (Computer Networking is high)
6) If (Analytical skills is low) and (Communication skills is medium) and (Algorithmic Skills is high) then (Computer Networking is high)
7) If (Analytical skills is low) and (Communication skills is high) and (Algorithmic Skills is low) then (Computer Networking is medium)
8) If (Analytical skills is low) and (Communication skills is high) and (Algorithmic Skills is medium) then (Computer Networking is high)
9) If (Analytical skills is low) and (Communication skills is high) and (Algorithmic Skills is high) then (Computer Networking is high)
10) If (Analytical skills is medium) and (Communication skills is low) and (Algorithmic Skills is low) then (Computer Networking is low)
11) If (Analytical skills is medium) and (Communication skills is low) and (Algorithmic Skills is medium) then (Computer Networking is medium)
12) If (Analytical skills is medium) and (Communication skills is low) and (Algorithmic Skills is high) then (Computer Networking is high)
13) If (Analytical skills is medium) and (Communication skills is medium) and (Algorithmic Skills is low) then (Computer Networking is medium)
14) If (Analytical skills is medium) and (Communication skills is medium) and (Algorithmic Skills is medium) then (Computer Networking is high)
15) If (Analytical skills is medium) and (Communication skills is medium) and (Algorithmic Skills is high) then (Computer Networking is high)
16) If (Analytical skills is medium) and (Communication skills is high) and (Algorithmic Skills is low) then (Computer Networking is high)
17) If (Analytical skills is medium) and (Communication skills is high) and (Algorithmic Skills is medium) then (Computer Networking is high)
18) If (Analytical skills is medium) and (Communication skills is high) and (Algorithmic Skills is high) then (Computer Networking is high)
19) If (Analytical skills is high) and (Communication skills is low) and (Algorithmic Skills is low) then (Computer Networking is low)
20) If (Analytical skills is high) and (Communication skills is low) and (Algorithmic Skills is medium) then (Computer Networking is medium)
21) If (Analytical skills is high) and (Communication skills is low) and (Algorithmic Skills is high) then (Computer Networking is high)
22) . If (Analytical skills is high) and (Communication skills is medium) and (Algorithmic Skills is low) then (Computer Networking is medium)
23) If (Analytical skills is high) and (Communication skills is medium) and (Algorithmic Skills is medium) then (Computer Networking is high)
24) If (Analytical skills is high) and (Communication skills is medium) and (Algorithmic Skills is high) then (Computer Networking is high)
25) If (Analytical skills is high) and (Communication skills is high) and (Algorithmic Skills is low) then (Computer Networking is high)
26) If (Analytical skills is high) and (Communication skills is high) and (Algorithmic Skills is medium) then (Computer Networking is high)
27) If (Analytical skills is high) and (Communication skills is high) and (Algorithmic Skills is high) then (Computer Networking is high)

Machine learning and Big Data

1) If (Mathematics and Statistics Skills is low) and (Analytical Skills is low) then (Machine Learning and Big Data is low)
2) If (Mathematics and Statistics Skills is low) and (Analytical Skills is medium) then (Machine Learning and Big Data is low)
3) If (Mathematics and Statistics Skills is low) and (Analytical Skills is high) then (Machine Learning and Big Data is medium)
4) If (Mathematics and Statistics Skills is medium) and (Analytical Skills is low) then (Machine Learning and Big Data is medium)
5) If (Mathematics and Statistics Skills is medium) and (Analytical Skills is medium) then (Machine Learning and Big Data is high)
6) If (Mathematics and Statistics Skills is medium) and (Analytical Skills is high) then (Machine Learning and Big Data is high)
7) If (Mathematics and Statistics Skills is high) and (Analytical Skills is low) then (Machine Learning and Big Data is medium)
8) If (Mathematics and Statistics Skills is high) and (Analytical Skills is medium) then (Machine Learning and Big Data is high)
9) If (Mathematics and Statistics Skills is high) and (Analytical Skills is high) then (Machine Learning and

Big Data is high)

Cloud computing

1) If (Database Management Skills is low) then (Cloud Computing is low)
2) If (Database Management Skills is medium) then (Cloud Computing is medium)
3) If (Database Management Skills is high) then (Cloud Computing is high)

Network Security

1) If (Problem Solving Skills is low) and (Communication Skills is low) then (Network Security is low)
2) If (Problem Solving Skills is low) and (Communication Skills is medium) then (Network Security is low)
3) If (Problem Solving Skills is low) and (Communication Skills is high) then (Network Security is medium)
4) If (Problem Solving Skills is medium) and (Communication Skills is low) then (Network Security is medium)
5) If (Problem Solving Skills is medium) and (Communication Skills is medium) then (Network Security is high)
6) If (Problem Solving Skills is medium) and (Communication Skills is high) then (Network Security is high)
7) If (Problem Solving Skills is high) and (Communication Skills is low) then (Network Security is medium)
8) If (Problem Solving Skills is high) and (Communication Skills is medium) then (Network Security is high)
9) If (Problem Solving Skills is high) and (Communication Skills is high) then (Network Security is high)

C. Fuzzy Set for the Input

Each input given in the fuzzy system can be classified into one of the three fuzzy sets; Low, Medium and High skill levels according to the membership function of relevant input. The rule evaluation can be defined for each input ensuring they are within the range of the skill considered (Table 2).

D. Fuzzy Set for the Input

Each output of the the fuzzy system can be classified into one of the three fuzzy sets; Low, Medium and High levels according to the membership function of relevant input. The rule evaluation can be defined for each output according to the range of the considered RA(Table 3).

TABLE II
INPUT FUZZY SETS AND RANGES

Statistics and Maths Fuzzy Set and Ranges		
Fuzzy Set	**Range**	**μ = 1**
Low	[0.00, 50.00]	25.00
Medium	[25.00, 75.00]	50.00
High	[50.00, 10.00]	75.00
Analytical Skills Fuzzy Set and Ranges		
Fuzzy Set	**Range**	**μ = 1**
Low	[0.00, 50.00]	25.00
Medium	[25.00, 75.00]	50.00
High	[50.00, 10.00]	75.00
Problem-Solving Skills Fuzzy Set and Ranges		
Fuzzy Set	**Range**	**μ = 1**
Low	[0.00, 50.00]	25.00
Medium	[25.00, 75.00]	50.00
High	[50.00, 10.00]	75.00
Communication Protocols Skills Fuzzy Set and Ranges		
Fuzzy Set	**Range**	**μ = 1**
Low	[0.00, 50.00]	25.00
Medium	[25.00, 75.00]	50.00
High	[50.00, 10.00]	75.00
Database Management Fuzzy Set and Ranges		
Fuzzy Set	**Range**	**μ = 1**
Low	[0.00, 50.00]	25.00
Medium	[25.00, 75.00]	50.00
High	[50.00, 10.00]	75.00
System Designing Fuzzy Set and Ranges		
Fuzzy Set	**Range**	**μ = 1**
Low	[0.00, 50.00]	25.00
Medium	[25.00, 75.00]	50.00
High	[50.00, 10.00]	75.00
Implementation Fuzzy Set and Ranges		
Fuzzy Set	**Range**	**μ = 1**
Low	[0.00, 50.00]	25.00
Medium	[25.00, 75.00]	50.00
High	[50.00, 10.00]	75.00
Algorithmic Skills Fuzzy Set and Ranges		
Fuzzy Set	**Range**	**μ = 1**
Low	[0.00, 50.00]	25.00
Medium	[25.00, 75.00]	50.00
High	[50.00, 10.00]	75.00

E. Input and Output Membership Functions

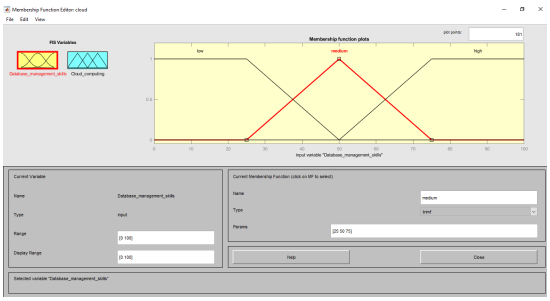

Fig. 1. Database management Memebrship Function

TABLE III
OUTPUT FUZZY SETS AND RANGES

Machine learning and Big Data Fuzzy Set and Ranges		
Fuzzy Set	**Range**	μ **= 1**
Low	[0.00, 50.00]	25.00
Medium	[25.00, 75.00]	50.00
High	[50.00, 10.00]	75.00
Network Security Fuzzy Set and Ranges		
Fuzzy Set	**Range**	μ **= 1**
Low	[0.00, 50.00]	25.00
Medium	[25.00, 75.00]	50.00
High	[50.00, 10.00]	75.00
Cloud Computing Fuzzy Set and Ranges		
Fuzzy Set	**Range**	μ **= 1**
Low	[0.00, 50.00]	25.00
Medium	[25.00, 75.00]	50.00
High	[50.00, 10.00]	75.00
Embedded Systems Fuzzy Set and Ranges		
Fuzzy Set	**Range**	μ **= 1**
Low	[0.00, 50.00]	25.00
Medium	[25.00, 75.00]	50.00
High	[50.00, 10.00]	75.00
Computer Networking Fuzzy Set and Ranges		
Fuzzy Set	**Range**	μ **= 1**
Low	[0.00, 50.00]	25.00
Medium	[25.00, 75.00]	50.00
High	[50.00, 10.00]	75.00

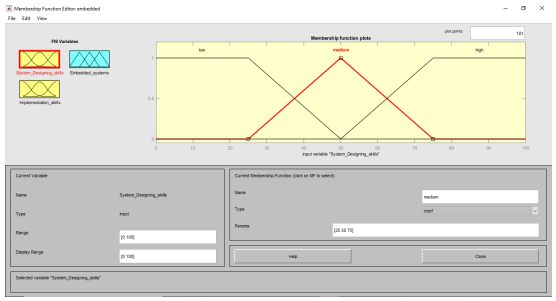

Fig. 2. System Designing Memebrship Function

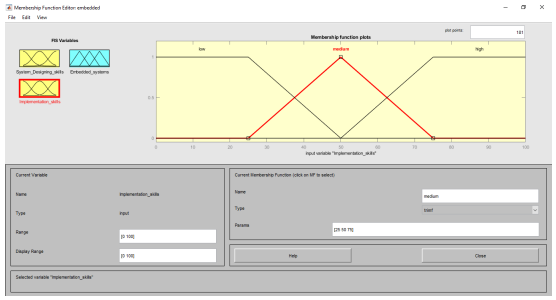

Fig. 3. Implementation Memebrship Function

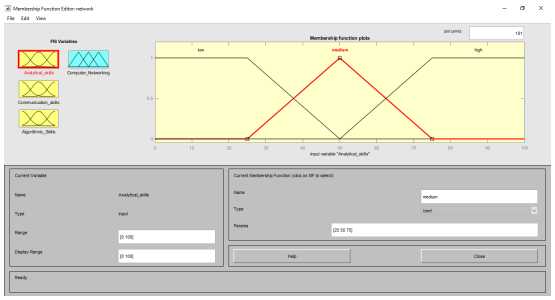

Fig. 4. Analytical Skills Memebrship Function

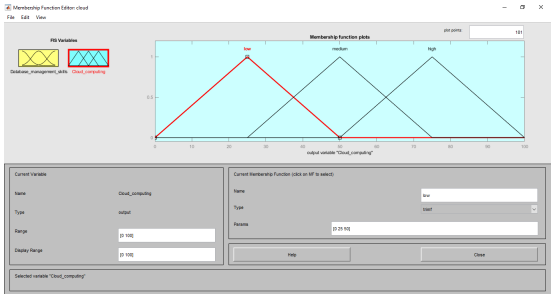

Fig. 5. Cloud computing Memebrship Function

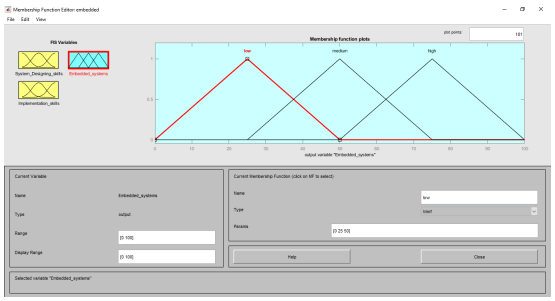

Fig. 6. Embedded systems Memebrship Function

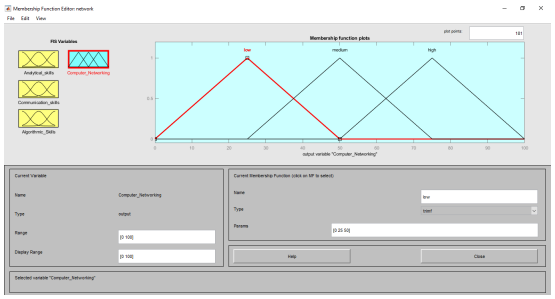

Fig. 7. Computer Networking Memebrship Function

F. Fuzzy Model

As the Fuzzy Inference System, Mamdani model was used which is well suited for human input which is processed in RA selection process. The model gives more interpretable rule base to process with the fuzzy model.As the Defuzzification method, centrod method was used.

IV. RESULTS

The rule viewer for each output visualizes the results of the fuzzy system.

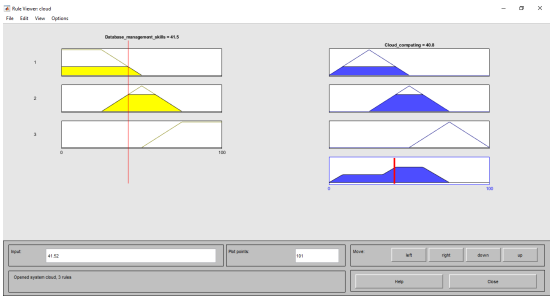

Fig. 8. Rule Viewer for Cloud Computing

Fig. 9. Rule Viewer for Embedded Systems

Fig. 10. Rule Viewer for Machine learning and Big Data

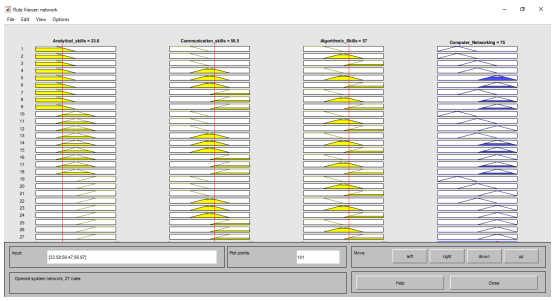

Fig. 11. Rule Viewer for Computer Networking

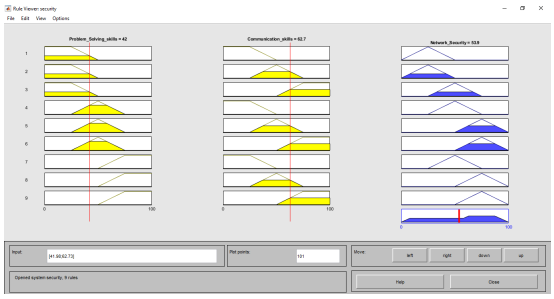

Fig. 12. Rule Viewer for Network Security

V. CONTRIBUTION

- Fuzzy System Design - E/16/078, E/16/369, E/16/168, E/16/275
- Fuzzy System Developmenet - E/16/369, E/16/275
- Fuzzy system Implementation - E/16/168, E/16/078
- Gui Implementation - E/16/275, E/16/369
- Readme - E/16/369
- Report - E/16/078, E/16/168
- Demo video - E/16/275

VI. REFERENCES

Course recommendation system using fuzzy logic approach https://www.researchgate.net/publication/339138230_Course_recommendation_system_using_fuzzy_logic_approach

A fuzzy based recommendation system with collaborative filtering https://ieeexplore.ieee.org/document/7083524