A Fuzzy Inferencing System for Highlighting the Complexities Involved in Electronic Surveys with Emotions

Mumtaz Ahmed†, Shabbar Naqvi†, Irfan Ali††, Salah Uddin†††, Aamir Zeb Shaikh††††

†Department of Computer Systems Engineering, Balochistan University of Engineering & Technology, Khuzdar Pakistan
††Department of Basic Sciences, Balochistan University of Engineering & Technology, Khuzdar Pakistan
†††Department of Civil Engineering, Balochistan University of Engineering & Technology, Khuzdar Pakistan
††††Department of Telecommunication Engineering, NED University of Engineering & Technology Karachi

Summary
There is a need to consider complexity involving surveys with emotions where emotions can substantially affect the outcome of the survey. Fuzzy logic is a well-known tool used to develop system involving uncertainties and ambiguities. This research work deals with application of fuzzy logic in electronic surveys while considering emotions of the surveyor as well for Higher Educational Institutes (HEIs).
In this work, a Fuzzy Inferencing System (FIS) based framework has been developed which combines the Electronic survey complexity with emotions. For this purpose, a previously developed E-Survey application has been used to conduct a survey using emotion detection system. It is followed by two cascaded FIS, which have been developed to highlight the complexities involved in performing electronic surveys while having different emotions. The results have shown that the proposed framework is able to report the significance of emotions while conducting surveys. Results also show difference between survey done without considering emotions and with emotions. Statistical tools have been used to interpret the results.
Key words:
Fuzzy Logic, E-Survey, FIS, Emotions, HEIs.

1. Introduction

For data collection, different kind of surveys are considered important such as Electronic surveys, which are cost-effective and convenient. These types of surveys are also used by, Higher Educational Institutions (HEIs) to record feedback of students and take different measures to improve the quality of teaching in HEIs. The results of surveys are helpful in key decision making of the University in terms of academia from quality of courses to evaluation of teachers etc. [1]. This trend is found not only in general HEIs but also in professional institutes e.g. engineering institutes etc. As we have mentioned in our previous work that, may be lack of motivation and interest causes students showing minimal interest in attempting these electronic surveys which do not result in reliable data to be used for analysis [2]. A lot of research in identifying psychological factors have been done. Generally, Psychologists working on cognitive domain have identified factors such as temporary mood state, fatigue, emotions and careless responses [3]. Generally, there is an ambiguity of opinion involved in survey responses due to overlapping nature of response levels [4] and closed format questionnaires are associated with a natural ambiguity of the responses [5], as the respondent's genuine opinion would be, not a single point, but rather a distribution of points around some central position i.e., "strongly disagree," "disagree," and so on. For such questions, respondents will not always respond the same way to the same question even if their attitudes remain unchanged. A subject may say, "Strongly agree" one time and "agree" the next, simply because of the ambiguity.
Emotions may affect the responses in electronic surveys, which is a serious problem, and which may cause the results to be become biased due to uncertain responses. This bias may result in serious issues in case of HEIs' surveys such as the reduced performance of a competent faculty member in the result of a survey done by a student. Keeping in view, the importance of problem domain revealed from literature, such complexities need to be addressed.
Soft computing based solutions such as Fuzzy Logic help to deal with uncertainty more appropriately as compared to any other technique [6]–[8]. It is one of the widely used techniques used in intelligent problem resolving system and applications. It has resulted in solving problems having complications in terms of high level of involvement of various uncertainties [9].
In the current work we have developed a fuzzy inferencing system (FIS) for dealing with complexities in terms of ambiguities involved in electronic surveys with emotions. Section 2 describes Research Methodology whereas Section 3 discusses the development method of FIS. In Section 4, detailed description of dataset used, obtained results and their discussion is included. Lastly, Section 5 provides conclusion and future work.

2. Research Methodology

Figure 1 shows the overall methodology of the developed system. It can be seen that in Step 1 user performs survey using an e-survey application which also captures emotions shown by the user. In e-survey application a user is asked to

Manuscript received October 5, 2019
Manuscript revised October 20, 2019

record to a series of questions based on Higher Education Commission Pakistan (HEC) quality assurance questionnaire having 20 questions and response is recorded in terms of a 1-5 Likert Scale where 1 represents complete disagreement and 5 represents complete agreement. Figure 2 shows the HEC questionnaire.

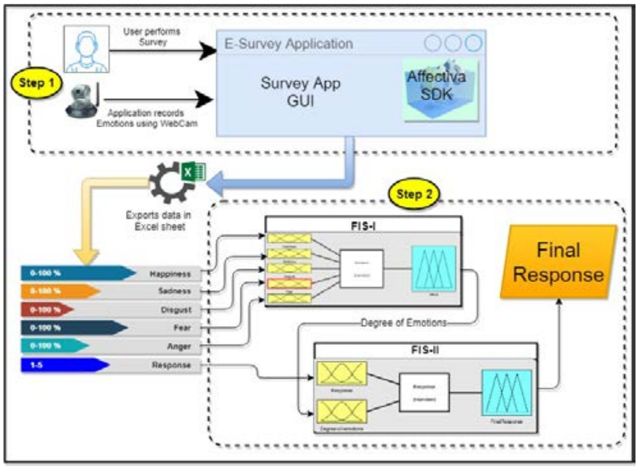


Fig. 1 Block diagram of the proposed system.

Student Course Evaluation Questionnaire
(To be filled by each Student at the time of Course Completion)

Questionnaire	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
1. The course objectives were clear	☐	☐	☐	☐	☐
2. The Course workload was manageable	☐	☐	☐	☐	☐
3. The Course was well organized (e.g. timely access to materials, notification of changes, etc.)	☐	☐	☐	☐	☐
4. I think the Course was well structured to achieve the learning outcomes (there was a good balance of lectures, tutorials, practical etc.)	☐	☐	☐	☐	☐
5. The learning and teaching methods encouraged participation.	☐	☐	☐	☐	☐
6. The overall environment in the class was conducive to learning.	☐	☐	☐	☐	☐
7. Classrooms were satisfactory	☐	☐	☐	☐	☐
8. The Course stimulated my interest and thought on the subject area	☐	☐	☐	☐	☐
9. The pace of the Course was appropriate	☐	☐	☐	☐	☐
10. Ideas and concepts were presented clearly	☐	☐	☐	☐	☐
11. The method of assessment were reasonable	☐	☐	☐	☐	☐
12. Feedback on assessment was timely	☐	☐	☐	☐	☐
13. Feedback on assessment was helpful	☐	☐	☐	☐	☐
14. I understood the lectures	☐	☐	☐	☐	☐
15. The material was well organized and presented	☐	☐	☐	☐	☐
16. The instructor was responsive to student needs and problems	☐	☐	☐	☐	☐
17. Had the instructor been regular throughout the course?	☐	☐	☐	☐	☐
18. The material in the tutorials was useful	☐	☐	☐	☐	☐
19. I was happy with the amount of work needed for tutorials	☐	☐	☐	☐	☐
20. The tutor dealt effectively with my problems	☐	☐	☐	☐	☐

Fig. 2 HEC Survey Questionnaire [10]

Besides that, e-survey application also records emotions of the user while selecting any choice using a digital webcam. The emotions have five parameters i.e., Happiness, Sadness, Disgust, Fear, Anger. In summary in Step 1 a total of six parameters are recorded, five based on emotions and one based on the response of the question as per Likert Scale. The details of our developed e-survey application can be found in [2].

3. Development of FIS

In Step 2 of the proposed research methodology, we have developed two inferencing systems. The first fuzzy system uses 5 input parameters of emotions to determine the Degree of Emotions, which is used as an input in second FIS.

The second fuzzy system determines the Final Response considering two inputs i.e., the degree of emotions, which is the output of the first fuzzy system and the respondent's response The Final Response provides better insight into the problem being studied. Initially, both FIS are developed using Triangular Membership Functions (TriMFs) having weight of one (1) for all the rules. The development of both FIS is discussed in subsequent sections.

3.1 Development of First Fuzzy Inferencing System (FIS-I)

The MATLAB ® Fuzzy Logic toolbox has been used for the development of FIS. There are two popular FIS models i.e. Mamdani FIS and Sugeno FIS. In this study, we have used Mamdani type FIS as it is widely used, in developing fuzzy models [11]. It has been represented in Figure 3.

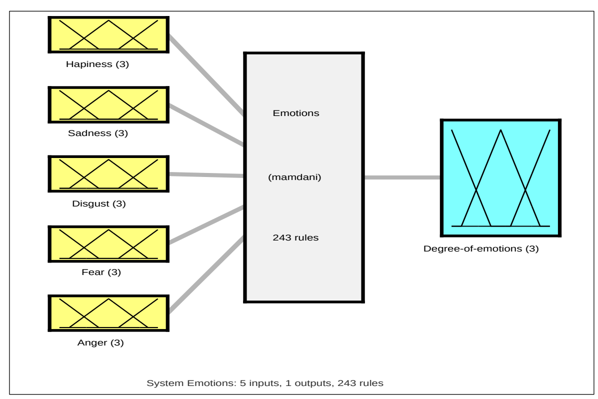


Fig. 3 Snapshot of Input and Output of FIS-I

For Stage 1, in the input linguistic variables for parameters are defined as in Table 1. The column titled as MFs in Table1 presents three different situations (Low, Medium and High) of the Happiness, Sadness, Disgust, Fear and Anger levels, which accordingly represent various changes in Degree of Emotions.

The third column shows the input range of each parameter, which ranges from 0 to 100 as it shows the level of emotion in percentage. For the ease, we have used 0 to 100 as values instead of percentage. While, the output linguistic variable i.e., degree of emotions is represented using three membership functions (Negative, Normal and Positive) ranging from 0 to 1 as shown in Table 2.

Table 1: Input Linguistic Variables FIS-I

Parameter	MFs	Input range
Happiness	Low(L), Medium(M), High(H)	0 to 100
Sadness	Low(L), Medium(M), High(H)	0 to 100
Disgust	Low(L), Medium(M), High(H)	0 to 100
Fear	Low(L), Medium(M), High(H)	0 to 100
Anger	Low(L), Medium(M), High(H)	0 to 100

Table 2: Output Linguistic Variables FIS-I

Parameter	MFs	Output range
Degree of Emotions	Negative, Normal, Positive	0 to 1

Initially, we have used triangular membership function (trimf), because it is the simplicity [60]. Figure 4 represents the membership functions of the input linguistic variables i.e., Happiness, Sadness, Disgust, Fear, and Anger. Figure 5 represents the membership function of the output linguistic variable i.e., Degree of Emotions.

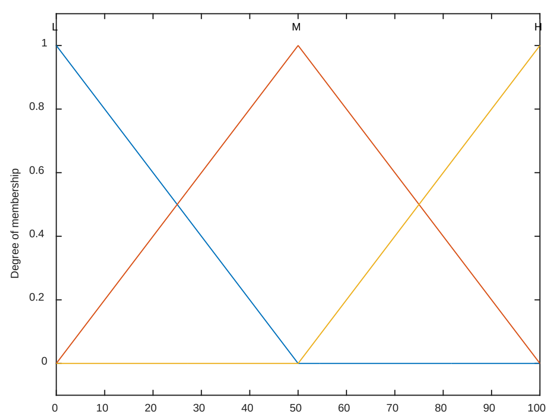


Fig. 4 Input Membership Function of FIS-I.

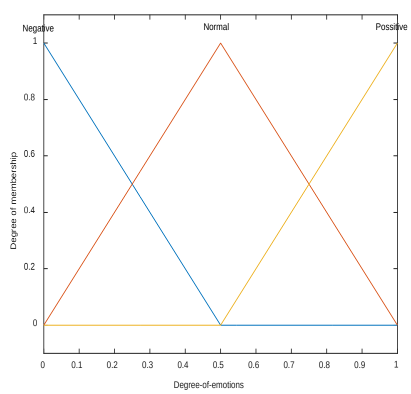


Fig. 5 Output Membership Function of FIS-I.

In Stage 2, a set of two hundred and forty-three (243) fuzzy rules are used with conjunction (AND) operator, which are selected using the following formula for calculating permutation with repetition.

$$Number\ of\ Rules = n^r \quad (1)$$

Where n is the number of membership functions of each input and r is the number of input parameters [14]. The general form of rule base is as under:

R_i: IF *Happiness* is μ_{i1} AND *Sadness* is μ_{i2} AND *Disgust* is μ_{i3} AND *Fear* is μ_{i4} AND *Anger* is μ_{i5} THEN *Degree-of-Emotion* = DE_i (2)

Where, R_i represents the i-th rule in the rule set, the μ_i is the MF of the antecedent part of the i-th rule for each input variable and DE_i is the degree-of-Emotion output. The example is presented with the help of the following scenario.

Rule = If Happiness is Low and Sadness is Low and Disgust is Low and Fear is Low and Anger is High then Degree of Emotion is Negative (3)

Stage 3 is the Defuzzification Stage. There are several methods, The Centre of Gravity (COG) or centroid method is used because it is the most popular method and is commonly used [12].
The output of FIS-I determines the Degree of Emotion and is used as input in FIS-II. In the next section, the development of FIS-II is given.

3.2 Development of Second Fuzzy Inferencing System (FIS-II)

The FIS-II is developed to determine the Final Response considering Degree of Emotions and Response. It has been developed using the Mamdani inferencing method. The input-output of FIS-II are represented in Figure 6.

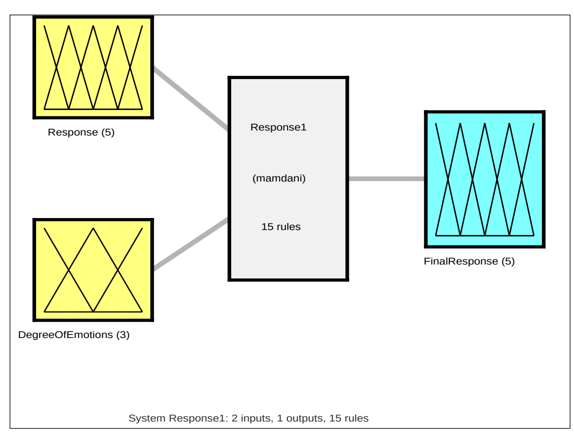


Fig. 6 Response FIS.

In Stage 1, the input linguistic parameters are defined as in Table 3.

Table 3: FIS-II Input Linguistic Variables

Parameter	MFs	Input range
Response	Strongly Disagree (SD), Disagree (D), Neither Agree Nor Disagree (NN), Agree (A), Strongly Agree (SA)	1 to 5
Emotions	Negative, Normal , Positive	0 to 1

There are two inputs, one is coming from FIS-I which is Degree of Emotion and second is Response of student survey. The membership functions of Response are based on five-point Likert scale labeled as Strongly Disagree, Disagree, Neither Agree Nor Disagree, Agree and Strongly Agree ranging from 1 to 5. The second input is the Degree of Emotion which has three membership functions i.e., Negative, Normal, Positive which ranges from 0 to 1.

Table 4: FIS-II Output Linguistic Variables

Parameter	MFs	Output range
Final Response	Strongly Disagree (SD), Disagree (D), Neither Agree Nor Disagree (NN), Agree (A), Strongly Agree (SA)	1 to 5

Table 4 shows the output linguistic variable i.e., Final Response. The membership functions of Final Response are based on five-point Likert Scale labels.

Figure 7, 8 and 9 characterize the MFs of input response, input Emotions, and output response respectively. All the MFs have been created using triangular MF.

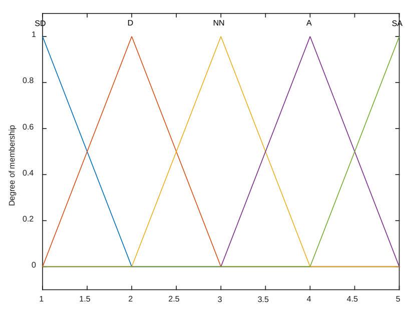


Fig. 7 MF of Response FIS-II.

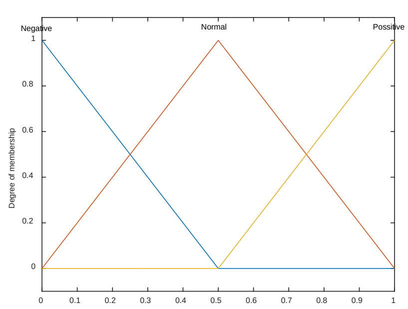


Fig. 8 MF plot of input variable Degree of Emotions FIS-II.

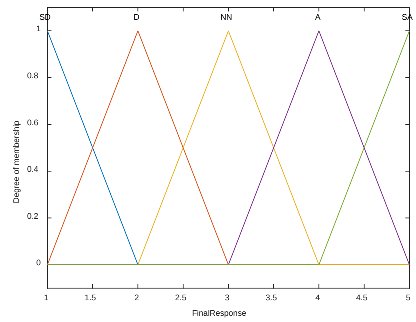


Fig. 9 MF plot of Output variable Final Response FIS-II.

In Stage 2, a set of fifteen fuzzy rules is used which includes all possible combination where order is not important, and repetition is allowed. The conjunction (AND) operator is used to join variables that allow a rule to fire when all conditions are met. The number of rules is calculated using the formula:

$$Number\ of\ rules = \frac{(r+n-1)!}{r!(n-1)!} \qquad (4)$$

Where n is the number of MFs, while r is the number of inputs of FIS-II. The list of rules is shown below:

1. If (Response is SD) and (Degree-of-Emotions is Negative) then (FinalResponse is NN) (1)

2. If (Response is SD) and (Degree-of-Emotions is Normal) then (FinalResponse is SD) (1)

3. If (Response is SD) and (Degree-of-Emotions is Positive) then (FinalResponse is SD) (1)

4. If (Response is D) and (Degree-of-Emotions is Negative) then (FinalResponse is NN) (1)

5. If (Response is D) and (Degree-of-Emotions is Normal) then (FinalResponse is D) (1)

6. If (Response is D) and (Degree-of-Emotions is Positive) then (FinalResponse is D) (1)

7. If (Response is NN) and (Degree-of-Emotions is Negative) then (FinalResponse is NN) (1)

8. If (Response is NN) and (Degree-of-Emotions is Normal) then (FinalResponse is NN) (1)

9. If (Response is NN) and (Degree-of-Emotions is Positive) then (FinalResponse is NN) (1)

10. If (Response is A) and (Degree-of-Emotions is Negative) then (FinalResponse is A) (1)

11. If (Response is A) and (Degree-of-Emotions is Normal) then (FinalResponse is A) (1)

12. If (Response is A) and (Degree-of-Emotions is Positive) then (FinalResponse is A) (1)

13. If (Response is SA) and (Degree-of-Emotions is Negative) then (FinalResponse is SA) (1)

14. If (Response is SA) and (Degree-of-Emotions is Normal) then (FinalResponse is SA) (1)

15. If (Response is SA) and (Degree-of-Emotions is Positive) then (FinalResponse is SA) (1)

In Stage 3, Centre of gravity (COG) or centroid defuzzification method has been used because of its popularity and commonly usage [12].

4. Results and Discussion

In this section, we provide detailed analysis and comparison of results using two different FIS and graphical representation of data collected using E-Survey application based on HEC survey questionnaire. Before the analysis, we provide the description of statistical terms used for analysis in this research in Table 5. For this research same dataset has been used which was initially used to develop e-survey application. It consists of 307 students responding to 20 questions, which provide a total number of 6140 observations [2].

Table 5: Description of Statistical Terms

S #.	Variable	Description
1	Mean	The mean of data set is the average of all the data values. The mean provides a measure of central location [15].
2	Median	The median of a data set is the value in the middle when the data items are arranged in ascending order. Whenever there are outliers, the median is the most preferred measure of central tendency [15].
3	**Standard deviation**	The standard deviation is a statistic that measures the dispersion of a dataset relative to its mean [16].
4	**Skewness**	Skewness is asymmetry in a statistical distribution, in which the curve appears distorted or skewed either to the left or to the right [15].
5	**Kurtosis**	Kurtosis is the measure of the thickness or heaviness of the tails of a distribution [17]. It is the degree of tailedness/skewness of a distribution [18].

4.1 Analysis of FIS Output

In this section, we discuss the analysis of FIS output. Initially, we have developed FIS-I and FIS-II using Triangular Membership Functions (MFs) namely (Tri-Tri MFs), besides this, we have also applied the other membership functions which are discussed in later sections. Here we present an in-depth analysis of FIS with Tri-Tri MFs.

The result of FIS-I is presented in Table 9, which represents the statistical analysis of five input parameters of emotions and the resulting output. The output shows that mean of degree of emotions is 0.50 which indicates that majority of students behaved normally during the survey. The median of output is 0.50 shows that we have same proportion of positively and negatively emotional students. Overall the output data is negatively skewed, while JB has the probability of zero, which indicate that data is not Gaussian.

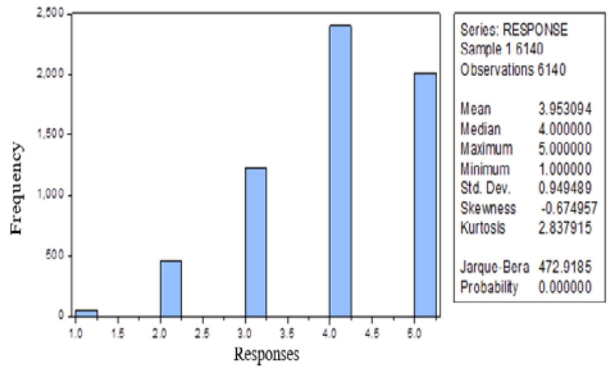
Table 6: Result of FIS-I

	Inputs					**Output**
	Anger	**Sadness**	**Disgust**	**Fear**	**Happiness**	**Degree of Emotions**
Mean	0.989204	1.416445	1.727197	0.648921	3.872582	0.489333
Median	0.002056	0.024418	0.426610	0.004553	0.001828	0.500000
Maximum	99.56900	99.87600	99.97500	99.35800	99.93100	0.813990
Minimum	0.000000	0.000000	0.000000	0.000000	0.000000	0.164920
Std. Dev.	6.869681	6.929975	9.093386	5.294241	19.01281	0.060194
Skewness	10.19724	7.511853	9.051949	10.72222	4.775132	-4.611228
Kurtosis	119.1874	75.18718	88.91140	135.9492	23.91303	25.81716
Jarque-Bera	3560038.	1390889.	1972097.	4639629.	135223.8	154952.2
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	6073.713	8696.972	10604.99	3984.375	23777.65	3004.508
Sum Sq. Dev.	289714.8	294822.7	507631.9	172070.0	2219169.	22.24382
Observations	6140	6140	6140	6140	6140	6140

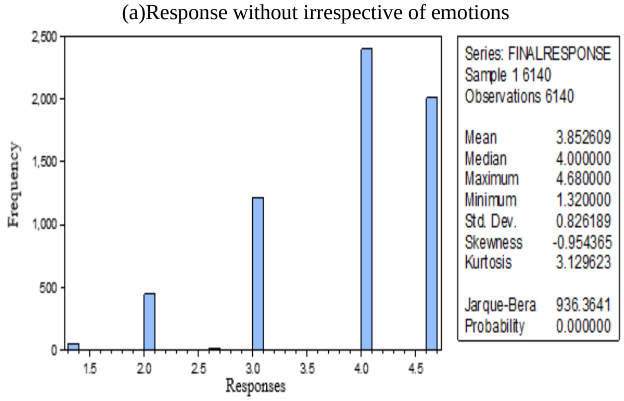
The result of FIS-II is shown in Table 10. It demonstrates that the average of Response is 3.95 while the average of final response is 3.85 which postulates the average has decreased after evaluating data from FIS. This decrease in average indicates that response of students has been tuned by FIS on both sides, reducing the Maximum value from 5 to 4.68 and increasing Minimum value from 1 to 1.32. Both indicate that response level has been moved toward a neutral point. There is no change in median which indicates that after executing FIS the structure of data mainly remained the same as displayed in Table 10.

Table 7: Result of FIS-II

	Input-I	**Input-II**	**Output**
	Degree Of Emotions	**Response**	**Final Response**
Mean	0.489333	3.953094	3.852609
Median	0.500000	4.000000	4.000000
Maximum	0.813990	5.000000	4.680000
Minimum	0.164920	1.000000	1.320000
Std. Dev.	0.060194	0.949489	0.826189
Skewness	-4.611228	-0.674957	-0.954365
Kurtosis	25.81716	2.837915	3.129623
Jarque-Bera	154952.2	472.9185	936.3641
Probability	0.000000	0.000000	0.000000
Sum	3004.508	24272.00	23655.02
Sum Sq. Dev.	22.24382	5534.491	4190.411
Observations	6140		



(a)Response without irrespective of emotions



(b)Response with emotions

Fig. 10 Histogram (a) and (b) Comparing Response FIS adjusted Response.

Thus, the statistical analysis shows that data is negatively skewed as response and the final response has negative values of skewness. While all emotions are positively skewed as shown in Table 10. Jarque-Bera test indicates that all the variables are not normally distributed as their probability values less than 0.05 as displayed in Table 10 and Figure 12. Overall the FIS worked well and tuned data by adjusting the final response towards their neutral point i.e., Neither-Agree-Nor-Disagree based on degree of emotions. In the next section, analysis of FIS with various Membership functions is discussed.

4.2 Comparison of FIS Results With Different Membership Functions

In order to test FIS with different membership functions, we have developed various setups as shown in Table 11. Setup-I, which is named as Tri-TriMF, indicates that the FIS-I of this setup is based on Triangular MF while the FIS-II is developed using Triangular MF. The further setups are developed using the same pattern. In the previous section we have presented the analysis of Setup-I in detail. While the other setups are discussed subsequently.

Table 8: FIS Setups with Various MFs

	Name	FIS-I MFs	FIS-II MFs
Setup-I	Tri-Tri MF	Triangular MF	Triangular MF
Setup-II	Tri-Trap MF	Triangular MF	Trapezoidal MF
Setup-III	Tri-Gaus MF	Triangular MF	Trapezoidal MF
Setup-IV	Trap-Gaus MF	Trapezoidal MF	Gaussian MF
Setup-V	Trap-Trap MF	Trapezoidal MF	Trapezoidal MF
Setup-VI	Gaus- Gaus MF	Gaussian MF	Gaussian MF

The detailed comparison of the initial response of students with the responses of FIS having different membership functions is demonstrated in Table 12 and Figure 13. The comparison is based on four parameters i.e., mean, median, minimum and maximum value because of most commonly used methods.The mean of initial response is 3.95 while the mean of TriMF-TriMF, TriMF-TrapMF, TriMF-GausMF, TrapMF-GausMF and GausMF-GausMF is 3.85, 3.86, 3.77, 3.76 and 3.77 respectively. This indicates that the utmost adjustment is carried out by TrapMF-GausMF while the least adjustment is done by TriMF-TrapMF.

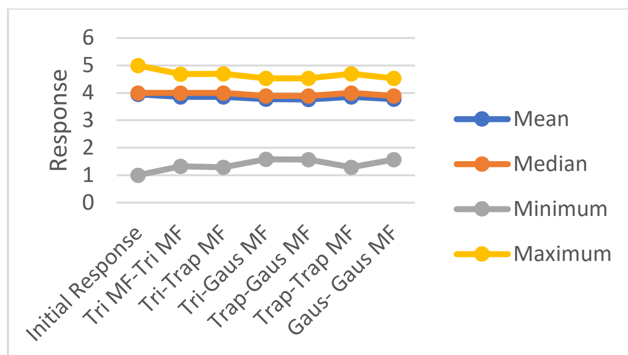


Fig. 11 Graph showing the comparison of FIS with various MFs.

The minimum value for initial response is 1 which is adjusted to 1.32, 1.29, 1.58, 1.57 and 1.57 in case of TriMF-TriMF, TriMF-TrapMF, TriMF-GausMF, TrapMF-GausMF and GausMF-GausMF respectively. The upward tuning carried out by TriMF-TriMF, TriMF-GausMF is 0.32 and 0.58 respectively, while the downward adjustment is 0.32 and 0.47 respectively. Overall, the highest tuning carried out by Tri-GausMF while the least tuning is made by Tri-TriMF squeezing the overall scale of measurement to 3.36 and 2.95 respectively.
It can be seen from the analysis that the data that emotions have a significant impact on survey responses and the impact of emotions on responses can be represented with fuzzy inferencing. The results direct us toward proving the hypothesis. Moreover, Fuzzy can be a comprehensive tool to deal with emotions and survey responses.

4.3 Rules Optimization

It was observed during the experiment process that some of all possible rules' composition was not a feasible choice. To optimize the rule base, we have dropped such rules in our rule base which are mathematically possible but technically not possible to occur in real life scenarios. For example, consider the following rule.

- If (Happiness is H) and (Sadness is H) and (Disgust is H) and (Fear is H) and (Anger is H) then (Degree of Emotion is Positive)

Table 9: Comparison of Results

	Initial Response	Tri MF -Tri MF	Tri-Trap MF	Tri-Gaus MF	Trap - Gaus MF	Trap - Trap MF	Gaus - Gaus MF
Mean	3.95	3.85	3.86	3.78	3.76	3.86	3.77
Median	4.0	4.0	4.0	3.90	3.89	4.0	3.89
Minimum	1.0	1.32	1.29	1.57	1.57	1.29	1.57
Maximum	5.0	4.68	4.71	4.54	4.53	4.70	4.53

It is unlikely that if a person is very happy and the same person is highly angry at the same time. The complexity of rule base increases due to the inclusion of such rules. So, we have dropped a total of 80 redundant rules out of 243. The remaining 163 rules have been used in the set of experiments. The result of the system after rules reduction is shown in Table 13.

Table 10: Comparison of FIS with different Rules

	Output of FIS	
	No. of Rules: 243	**No. of Rules: 163**
Mean	3.852609	3.852629
Median	4.000000	4.000000
Maximum	4.680000	4.680000
Minimum	1.320000	1.320000

The results indicate that after rules reduction the results remained almost the same with a very negligible change in Mean of output. As the reduction of such rule has no impact on the overall result because of these rules are not fired, as these such cases (rules) are technically rarely possible to occur in real life situation.

4.4 FIS Results After Adjusting the Weight of Rules

In this section, we tuned the weight of rules. The following algorithm is used to modify the weight of specific FIS. The script sets the weightage of each rule using iteration and random function techniques.

```
fis = readfis('Name Of FIS');
NewRules=fis.rule;
fis.rule=[];
disp('Number of Rules:')
disp( length(NewRules));
for i=1:length(NewRules)
  NewRules(i).weight=rand;
end;
fis.rule=NewRules;
showrule(fis)
writefis(fis, 'Name Of FIS with new weight');
```

The FIS modified with rules having random weightage between 0 to 1, and the output is recorded. The process has been repeated five times. Table 14 shows the comparison of initial FIS with FIS having randomly assigned weightage of rules. The mean, Median, Maximum and Minimum of randomly weighted output are reported in Table 13.
The Mean and Maximum values have been reduced, while the Minimum value increased in comparison to initial output with weightage of one. Which indicate that the randomly tuning the weightage of rules have impact on the result. The further tuning of weightage needs to be investigated and a proper mechanism for assigning weights to rules is required, so that more meaningful results may be obtained.

5. Conclusion and Future Work

This research focuses on describing the effect of emotions while conducting surveys and complexities involved in it. The dataset used for this research is restricted to surveys in HEIs of Pakistani University. Data of BUET Khuzdar has been used as a case study and for sampling. As fuzzy logic is a famous and common technique to deal with ambiguous data, therefore, we have selected it for our research. We have used an e-survey application for surveying students' feedback and the emotions while carrying out the survey. Fuzzy inferencing system (FIS) has been developed to deal with complexities involving surveys with emotions. FIS has been created compared with different type Membership functions and also with different weights to understand the complexities of the system from Computer Engineering perspective.
Our results have shown that emotions have a significant impact on survey responses and the impact of emotions on responses can be represented using fuzzy inferencing. The results have also shown that the proposed framework is able to highlight the significance of emotions while conducting surveys. Results also show difference between survey done without considering emotions and with emotions. This research is an initial step towards building a computational tool that can cover emotion handling in surveys while capturing complexities using fuzzy logic.

Table 11: Comparison of Results with Different Weights

	FIS Output					
	Weightage: 1	**Weightage: Random 0-1**				
		Iteration-1	**Iteration-2**	**Iteration-3**	**Iteration-4**	**Iteration-5**
Mean	3.852609	3.830368	3.841818	3.841818	3.838463	3.818155
Median	4.000000	4.000000	4.000000	4.000000	4.000000	4.000000
Maximum	4.680000	4.600000	4.648100	4.648100	4.636800	4.628600
Minimum	1.320000	1.480000	1.393500	1.393500	1.388900	1.428900

In future, we intend to obtain different data sets both locally and globally with variability and analyse the comparison of the results. Also fuzzy type-II is a technique which in recent times has been frequently used to deal with datasets with high level of complexity and there is scope of using it for the datasets obtained from surveys to capture high level of ambiguities found in data sets [22].

Acknowledgments

The authors are thankful to Balochistan University of Engineering and Technology Khuzdar for providing support for this research work. This research work is part of MS (Computer Engineering) work carried out at Balochistan UET Khuzdar Pakistan.

References

[1] B. John, R. Williams, and S. J. Brennan, A guide to good practice Collecting and using student feedback Published. Learning and Teaching Support Network (LTSN), 2004.
[2] M. Ahmed, S. Naqvi, I. Ali, J Shah and A Raza "Development of an E-Survey Application to deal with Complexities involved in Electronic surveys with Emotions in Higher Education Institutes", International Journal of Computer Science and Network Security, vol 19, no. 8, pp 78-81, 2019
[3] M. Heide and K. Gronhaug, "Respondents' Moods As a Biasing Factor in Surveys: an Experimental Study by Morten Heide and Kjell Gronhaug," ACR North American Advances, 1991. [Online]. Available: http://www.acrwebsite.org/search/view-conference-proceedings.aspx?Id=7218. [Accessed: 15-Sep-2017].
[4] P. Vonglao, "Application of fuzzy logic to improve the Likert scale to measure latent variables," Kasetsart Journal of Social Sciences, vol. 8, no. 1, 2017.
[5] S. Rosa, M. A. Gil, M. T. Lopez, and M. A. Lubiano, "Fuzzy Rating Scale-Based Questionnaires and Their Statistical Analysis," IEEE Transactions on Fuzzy Systems, vol. 23, no. 1, pp. 111–126, 2015.
[6] H.-J. Zimmerman, "Using fuzzy sets in operational research," European Journal of Operational Research, vol. 13, no. 3, pp. 201–216, Jul. 1983.
[7] S. Naqvi and J. M. Garibaldi, "An Overview of the Application of Fuzzy Inference System for the Automation of Breast Cancer Grading with Spectral Data," World Academy of Science, Engineering and Technology International Journal of Biomedical and Biological Engineering, vol. 6, no. 4, pp. 1084–1088, 2012.
[8] J. Mohammad, A. Titli, L. Zadeh, and S. Boverie, Applications of Fuzzy Logic: Towards High Machine Intelligence Quotient Systems. Prentice-Hall, Inc. Upper Saddle River, NJ, USA, 1997.
[9] Q. Li, "A novel Likert scale based on fuzzy sets theory," Expert Systems with Applications, vol. 40, no. 5, pp. 1609–1618, 2013.
[10] "QEC | Online Self-Assessment." [Online]. Available: http://www.buetk.edu.pk/qec/onlinesap.html. [Accessed: 21-Aug-2019].
[11] S. A. Moahmmed and P. B. Sattar Sadkhan, "A Comparison of Mamdani and Sugeno Fuzzy Inference Systems based on Block Cipher Evaluation," International Journal of Scientific & Engineering Research, vol. 4, no. 12, 2013.
[12] M. G. Voskoglou, "Comparison of the COG Defuzzification Technique and Its Variations to the GPA Index," American Journal of Computational and Applied Mathematics, vol. 6, no. 5, pp. 187–193, 2016.
[13] Paul Ekman, "The Ekmans' Atlas of Emotions." [Online]. Available: http://atlasofemotions.org/#continents/anger. [Accessed: 20-Aug-2018].
[14] R. Roman, J. Zhou, and J. Lopez, "Applying Intrusion Detection Systems to Wireless Sensor Networks."
[15] D. R. Anderson, D. J. Sweeney, and T. A. Williams, "Statistics for Business and Economics," Statistics for Business and Economics, Eleventh Edition, Solution Manuel to Acompany, pp. 1–41, 2010.
[16] "Standard Deviation." [Online]. Available: https://www.investopedia.com/terms/s/standarddeviation.asp. [Accessed: 03-Aug-2019].
[17] "What Is Kurtosis in Statistics?" [Online]. Available: https://www.thoughtco.com/what-is-kurtosis-3126241. [Accessed: 12-Oct-2018].
[18] "Statistics - Kurtosis." [Online]. Available: https://www.tutorialspoint.com/statistics/kurtosis.htm. [Accessed: 01-Sep-2019].
[19] C. M. Jarque, "Jarque-Bera Test," in International Encyclopedia of Statistical Science, Berlin, Heidelberg: Springer Berlin Heidelberg, 2011, pp. 701–702.
[20] O. Saadatian, S. B. I. N. Mat, C. H. Lim, E. Salleh, and K. Sopian, "A Methodology for Adapting Sustainability Tools," Advances in Fluid Mechanics and Heat & Mass Transfer, pp. 54–65, 2012.
[21] "Sample Size Calculator by Raosoft, Inc." [Online]. Available: http://www.raosoft.com/samplesize.html. [Accessed: 15-Oct-2018].
[22] Shabbar Naqvi, "Modelling FTIR spectral sets with Type-I and Type-II fuzzy sets for breast cancer grading ", PhD Thesis, University of Nottingham, 2014.

Mumtaz Ahmed Mengal completed his Master of Computer Engineering from Balochistan University of Engineering and Technology (BUET), Khuzdar in 2018 with distinction. He also done his Bachelor of Engineering in Computer Systems from BUET, Khuzdar. His research interests including real world application of fuzzy logic, Software Engineering, Geographic information system and use of advanced computational tools for problem solving.

Shabbar Naqvi received his B.E, and M.E degrees in Computer Systems Engineering from NED University of Engineering & Technology Karachi in the years 2001 and 2006 respectively. He received his Ph.D. degree in Artificial Intelligence from the University of Nottingham, in 2014.He is currently serving as an Associate Professor of Computer Engineering and as Dean Faculty of Sciences at Balochistan University of Engineering & Technology Khuzdar, Pakistan. His research interests include fuzzy modelling, big data analytics, and applications of Artificial Intelligence techniques in solving real world and Engineering problems.

Irfan Ali is a PhD Scholar in economics at Science in Economics from School of Social Sciences & Humanities (S3H), NUST Pakistan. He is a Gold Medalist in Maters of Science in Economics from S3H, NUST Pakistan. He holds over 9 years of research and teaching experience in Economics. Mr. Ali's area of interest is Economics. He is mainly interested in International trade/Economics, macroeconomics and econometrics.

Salah Uddin completed his M.E. in Structural Engineering from NED UET Karachi in 2004 and his BE from BUET, Khuzdar in 2001. He has obtained PhD in Civil Engineering from University of Nottingham, United Kingdom in 2012. He is currently serving as an Associate Professor of Civil Engineering and Head of the Department of Civil Engineering at Balochistan University of Engineering and Technology Khuzdar, Pakistan. His research interests include Experimental Geomechanics, advanced soil mechanics laboratory testing and mechanisms based on advanced computational methods for quality higher education.

Aamir Zeb Shaikh is working as an Assistant Professor in the Telecommunications Engineering Dept. of NED University. He completed his PhD in the area of Spectrum Sensing Cognitive Radios through a sandwich program between NED University Karachi and UT Dallas, TX, USA. He is engaged in research/ project supervision since 2002. He has authored/co-authored more than 12 journal papers in Thomson Reuters / HEC recognized indexed journals. His research interests include Cognitive Radio Networks, applications of Artificial Intelligence in Telecommunication and for enhancement of quality higher education.