A Fuzzy Based Assesment Model for Evaluation of Teaching Methods and Presentation Effect on Faculty Performance

(1) Yahaya Onimisi Mohammed
mdonimisi@Kfupm.edu.sa

(2) El- Sayyed El Alfy
alfy@kfupm.edu.sa

Information and Computer science Department
King Fahd University of Petroleum and Mineral
Dhahran 31261 Saudi Arabia

Abstract

Evaluation of teachers and facultiees play a greater role in the monitoring and improving the performance of our educational system. A survey of evalaution form normally given to student to access the performance of their faculties/Teachers reveals that the evaluation contains fuzzy statements such as strong, competent, unsatisfactory, agree, strongly agree etc. This vaguely defined variable is studied and fuzzified to model a discrete value to measure the performance on a scale that can easily be appraised

Keywords: fuzzy models, performance, assessment

1.0 Introduction

A credible and objective assessment is one of the major requirements for a good educational system. The need to be accurate in student assessment cannot be overemphasized. Assessment is required for student placement in school, in class, staff appraisal, school comparison and ranking and so on. In general, the main aim of subjective evaluation is to provide assessment of complex situation, object, or even possible to be action. In subjective evaluation problem, the situation under consideration is to be described in terms of various attributes. For these to be useful, it has to be accurate, consistent and uniformly implemented

2.0 Assessment Models

In general, assessment models have been studied and presented in literature. Assessment model is mathematical model, which quantifies a situation/object and produces a measuring index, either in a numerical score of a continuous scale or a category to a situation/ object taking into considerations its attribute(s) (Cunnigham, 1986, Chattergi, 2003). The estimated numerical score or category represents the level of criticality or wellness of the situation, with respect to the subject of measure (Dubois et al 1997; Fuguriera et al, 2005; Triantaphyllao, 2000 Kaliszevski, I. 2006). This will then leads to certain actions. Fuzzy ruled based assessments have been suggested and modeled in many areas of human endeavour such as in software Development, used to modeled rate of aggressive risk (Lily and Huey, 2007), in education for evaluation of students' project in engineering education (Baba et al, 2009), student achievement is evaluated using scoring rubric approach (Charttergi, 2003), scoring system for grading student writing (Nolan, 1998). For selection of shipping operation organization (Xinhua and Wenfa, 2008). In healthcare studies, assessment models were used by mental health clinician and

doctors to rate the social, occupational and psychological functioning of adults (Vandastone and Henderson, 2003).

Kai et al (2005), investigated and presented the main properties of Fuzzy based assessment models as monotone output property and output resolution properties and presented that FIS based assessment models which uses ruled base to describe the relationship between the inputs and the outputs demonstrated their ability in a variety of problem domains e.g. control, modeling and classification. He added that one of the key factors of their success is the ability to incorporate human knowledge where information can be described by vague and imprecise statements interpretable by humans.

Mahant (2004), in his paper, presented a fuzzy assessment model for risk management. Fuzzy logic provided a way to specify and characterized the imprecise variables in risk. Sometimes, student assessment could be based on various criteria not only on the academic performance but also on other qualities such as aptitude, creativity, leadership, initiative and so on. These are subjective qualities that imprecisely specified hence the need for a fuzzy ruled based assessment system.

Nolan (1998) reported that any type of grading system is a classification problem, hence, the use of a classification model based on a particular scoring rubrics will help to standardize the grading. The author introduced an expert fuzzy classification for grading student writing samples. They reported that the result increased consistency in the application of the scoring rubrics.

Zhu and Li (2009) presented a combination of fuzzy logic system and neural network model and applied it to teaching quality assessment, their results had a better appraisal effect and claimed that compared with other methods, it is simple and operable. In a related research, Xinhua and Wenfa (2008), used fuzzy assessment model for selecting shipping operation organization, this buttress the point that fuzzy classification have been applied in a varoius facet of life. However, in order for the assessment to be effective there is need for designed rubrics for performanced based evaluation.

3.0 How Fuzzy logic system works

Fuzzy logic was invented by Zadeh (1997) for handling uncertain and imprecise knowlegde in a real world application. It refers to a mode of reasoning in the presence of imprecise or ambigous information. Fuzzy logic is close to human thinking or reasoning as a natural langauage. Fuzzy logic provides a simple way to arrive at a definite conclusion based upon vague, ambiguous, imprecise, noisy, or missing input information. It consist of four cardinal components: Fuzzification, a knowlegde base, rulebase, a decision making mechanism and defuzzification.

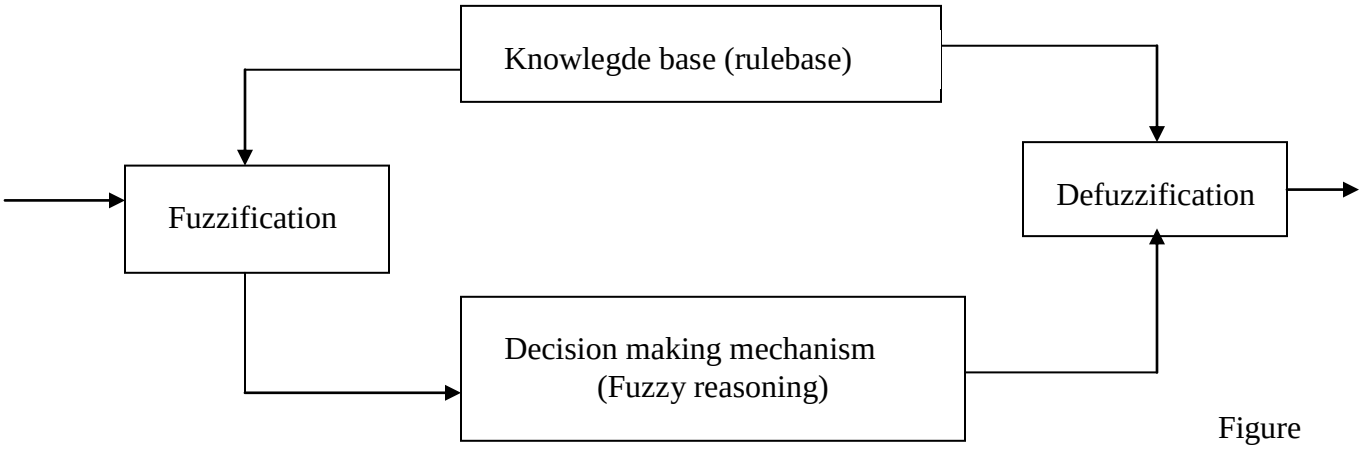


Figure 1. Fuzzy logic system

3. 1 Membership function

The membership function is a graphical representation of the magnitude of participation of each input (Brighthub, 2010). A graph that defines how each point in the input space is mapped to membership value between 0 and 1. Input space is often referred as the universe of discourse or universal set (u), which contain all the possible elements of concern in each particular. It associates a weighting with each of the inputs that are processed, define functional overlap between inputs, and ultimately determines an output response. The rules use the input membership values as weighting factors to determine

their influence on the fuzzy output sets of the final output conclusion. Once the functions are inferred, scaled, and combined, they are defuzzified into a crisp output which drives the system. There are different memberships functions associated with each input and output response. Some features to note are: Shape - triangular is common, but bell, trapezoidal, sigmoidal, pi-shaped, Guassian and, exponential have been used. More complex functions are possible but require greater computing overhead to implement height or magnitude (usually normalized to 1) width (of the base of function), Shouldering (locks height at maximum if an outer function. Shouldered functions evaluate as 1.0 past their center) center points (center of the member function shape) overlap (N&Z, Z&P, typically about 50% of width but can be less).

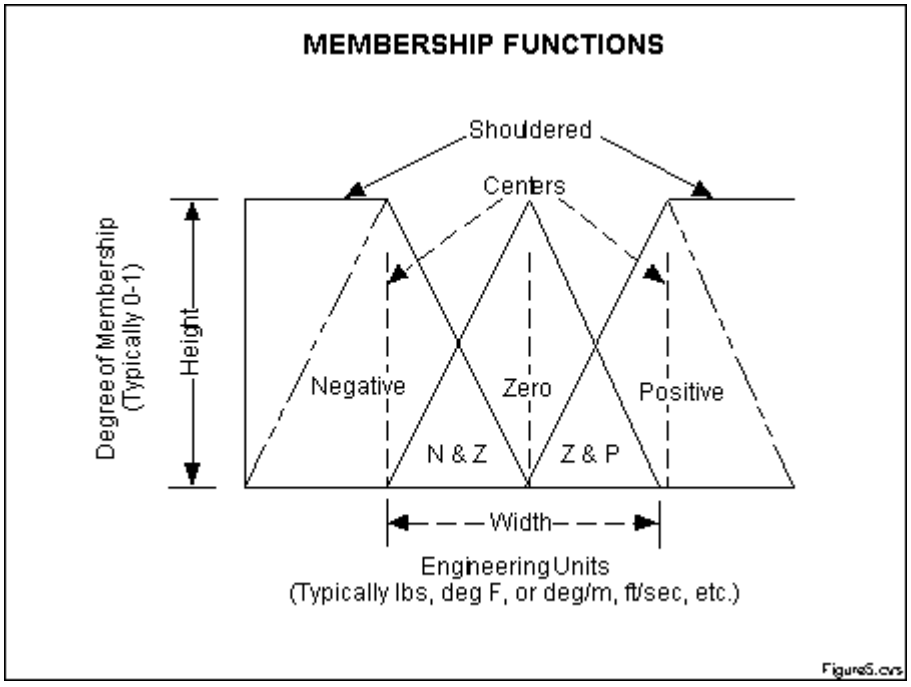


Figure2 - The features of a membership function

3.2 Fuzzification

The fuzzification comprises the process of transforming crisp values into grades of membership for linguistic terms of fuzzy sets. The membership function is used to associate a grade to each linguistic term (Brighthub, 2010). It also refers to as the transformation of an objective term into a fuzzy concept.

3. 3 Fuzzy rule base (knowlegde base)

Fuzzy logic classification systems are generally implemeted in the form of an expert decision support system. The rulebase contains the rules and forms the major part of the complete knowlegde embedded in the system. Mostly the rule are supplied by the domain expert.

3. 4 Fuzzy Rule Evaluation (inferencing)

This step is to determine the firing strength of each rule. The logical products for each rule must be combined or inferred before being passed on to the defuzzification process for crisp output generation. Several inference methods exist, the max-min method tests the magnitudes of each rule and selects the highest one. The horizontal coordinate of the "fuzzy centroid" of the area under that function is taken as the output. This method does not combine the effects of all applicable rules but does produce a continuous output function and is easy to implement. The max-dot or max-product method scales each member function to fit under its respective peak value and takes the horizontal coordinate of the "fuzzy" centroid of the composite area under the function(s) as the output. This method combines the influence of all active rules and produces a smooth, continuous output. Others are the averaging method and the root-sum-square (RSS) method.

3. 5 Defuzzification

When the inferencing is over. Ther is need to compute a single value to represent the outcome. This process is called defuzzification.This can be achieved with different methods.A common method is the defuzzification of the data into a crisp output is accomplished by combining the results of the inference process and then computing the "fuzzy centroid" of the area. The weighted strengths of each output member function are multiplied by their respective output membership function center points and summed. Finally, this area is divided by the sum of the weighted member function strengths and the result is taken as the crisp output.

4.0 A case study

We considered a sample faculty evaluation form from Southwestern College U S.A. which evaluated on the following scale (S) strong, (C) competent, (M) marginal and (U) unsatisfactory with the following range of values on a scale of 10 (Table 1) and The assessment criteria is listed in the table below (Table 2)

.

Table 1 : Teaching method and Presentation Evaluation Scale

S/N	Scale	Remark
1	8 - 10	Strong (S)
2	6 - 7	Competent (C)
3	4 - 5	Marginal (M)
4	1 - 3	Unsatisfactory (U)

Table 2: Performance Evaluation Criteria

S/no	Criteria
1	Organization of Lesson plan: organised progression from each activity to the next
2	Use of class timing: Puntuality and use of class time
3	Classroom management: control of Class room environment
4	Subject Matter Expertise: Mastery of and currency in subject
5	Teaching Methodologies (Pedagogy/Adragogy) Mastery of teaching skill and skill
6	Presentatuion and Delivery: Awareness of demeanore, vocabulary and articulation
7	Student Involvement: evidence of active engagement and participation by students
8	Learning Environment: Creates an environment conducive for learning
9	Rapport: Eveidence of mutual respect and professionalism
10	Overall Class visitation

Table 3: Performance evaluation scale

S/N	Scale	Remark
1	0 - 45	poor
2	45 - 60	Fair
3	65 - 80	Good
4	80 - 100	Excellent

We use the following rules to formulate our model.

1. If (TM is unsatisfactory) and (P&D is unsatisfactory) then (performance is poor) (1)
2. If (TM is marginal) and (P&D is marginal) then (performance is fair) (1)
3. If (TM is competent) and (P&D is competent) then (performance is Good) (1)
4. If (TM is strong) and (P&D is strong) then (performance is Exceptional) (1)
5. If (TM is unsatisfactory) and (P&D is marginal) then (performance is poor) (1)
6. If (TM is unsatisfactory) and (P&D is competent) then (performance is fair) (1)
7. If (TM is unsatisfactory) and (P&D is strong) then (performance is fair) (1)
8. If (TM is marginal) and (P&D is competent) then (performance is fair) (1)
9. If (TM is marginal) and (P&D is strong) then (performance is Good) (1)
10. If (TM is competent) and (P&D is strong) then (performance is Good) (1)
11. If (TM is marginal) and (P&D is unsatisfactory) then (performance is poor) (1)

5.0 Experiment

In our experiment, we assume, each of the criteria has equal effect on the perfomance of the Faculty been evaluated. That is each conform with the monotone output property of of assessment model. (see Figure 3) (Kai and Chee, 2008).

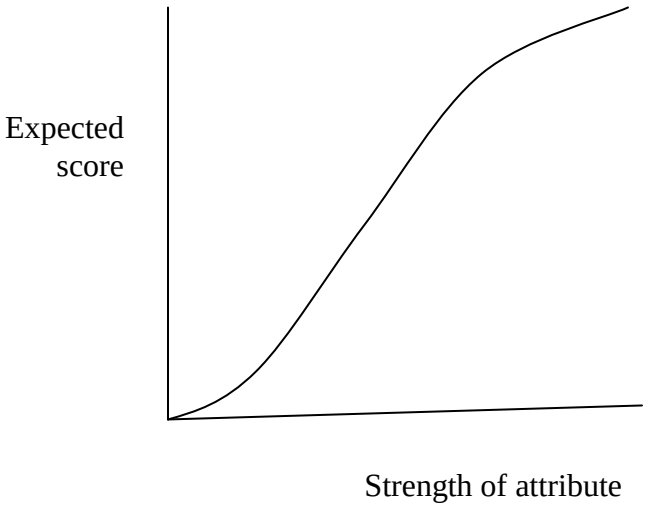


Figure 3: The expected score versus the strength of attribute of an ogive function.

6.0 Result

Table 4: Some Sample Model Evaluation result

	Teaching Method Scale (0 -10)	Presentation and Delivery Scale (0 -10)	Performance Scale (0 – 100)	Remark (Class)
1	1.48	1.99	17.7	Poor
2	2.92	3.58	18.9	Poor
3	3.62	4.34	45	Fair
4	5.0	5.0	45.1	Fair
5	5.06	5.73	48.7	Fair
6	5.88	6.87	65	Good
7	7.39	7.5	74.6	Good
8	8.71	7.5	86.5	Excellent
9	8.4	9.2	87.7	Excellent
10	0.505	5.0	17.7	Poor
11	1.97	5.59	31	Poor
12	2.8	6.68	45.1	Fair
13	0.96	6.68	45.1	Fair
14	1.61	9.68	45.1	Fair
15	9.04	0.59	45.1	Fair
16	7.57	0.864	45.0	Fair
17	8.58	0.864	45.1	Fair
18	8.58	3.59	45	Fair
19	7.66	7.77	80	Excellent
20	10	10	87.7	Excellent

As we can see the result obtained from the table, it is satisfy the assessment monotone property which shows the result of the model is reasonable and can be enhanced to include other grading criteria. It is also observed that if one value of the criteria is below some threshold the performance cannot be more than a particular range around 45 in this case as observed from the table. We can conclude that the two criteria has effect on each and directly affect the result of the performance.

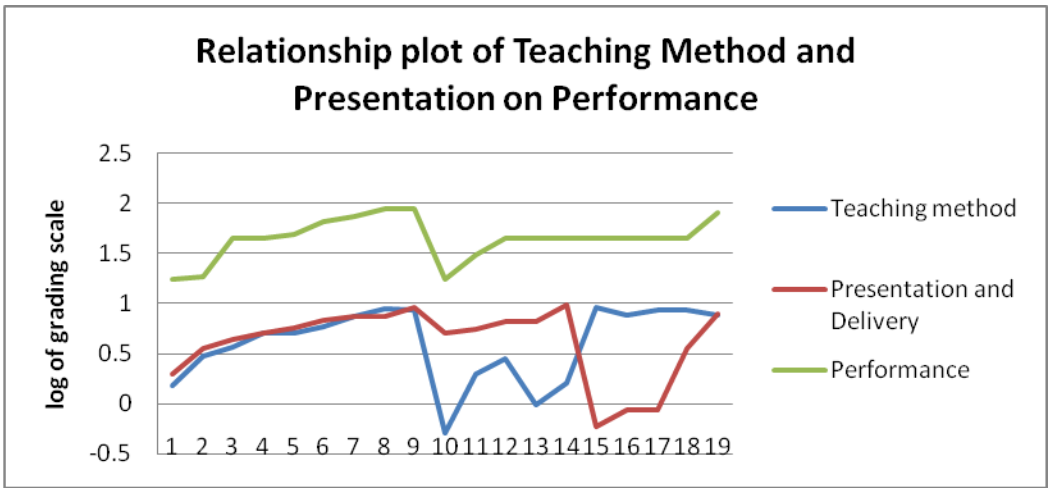


Figure 4: Plot to show the effect of Teaching Method and Presentation on performance

7.0 Conclusion

As we can observe from the result, fuzzy logic have been used to defined the vaguely specified inputs. Two of the performance criteria were selected Teaching Mmethod and presentation to study the effect on each other. This model can be improved upn by using input from experts and use real life data and extended to include other performance criteria indicated in the paper.

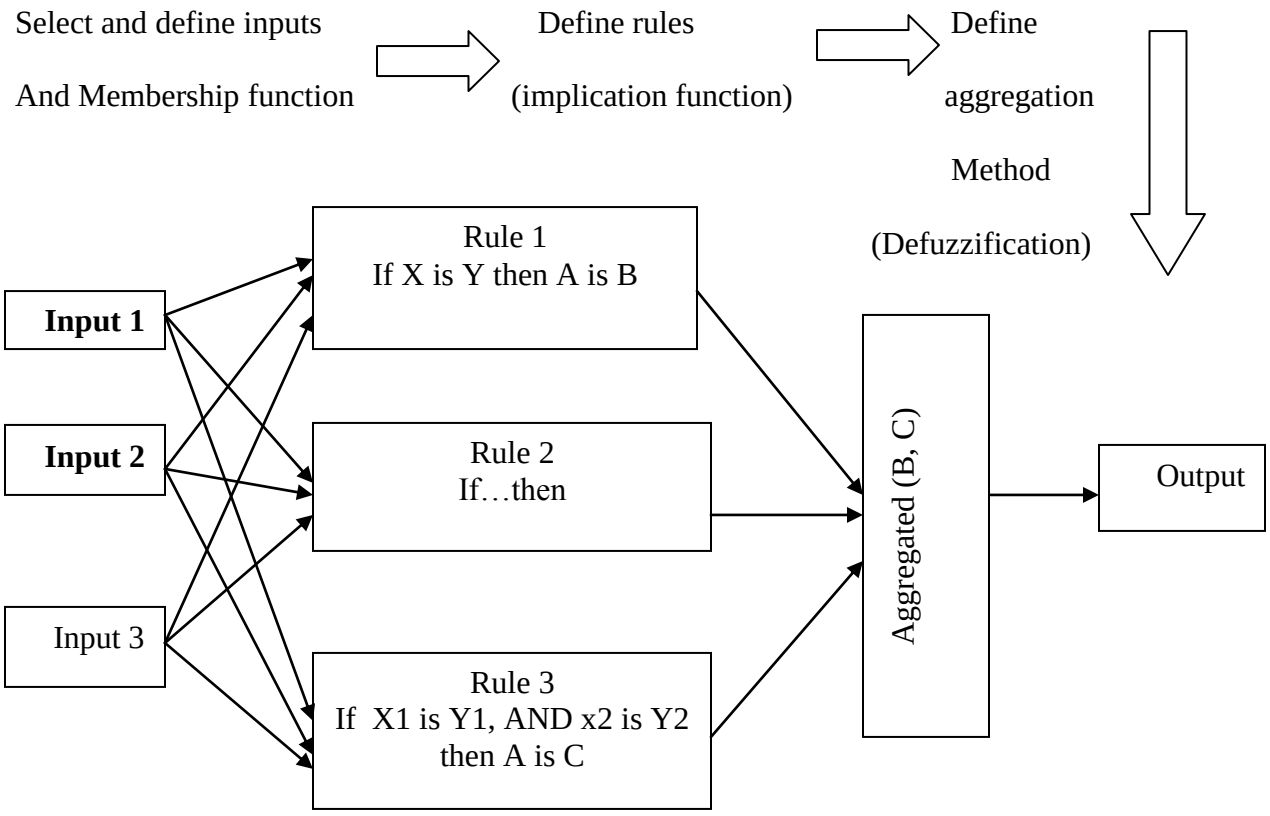
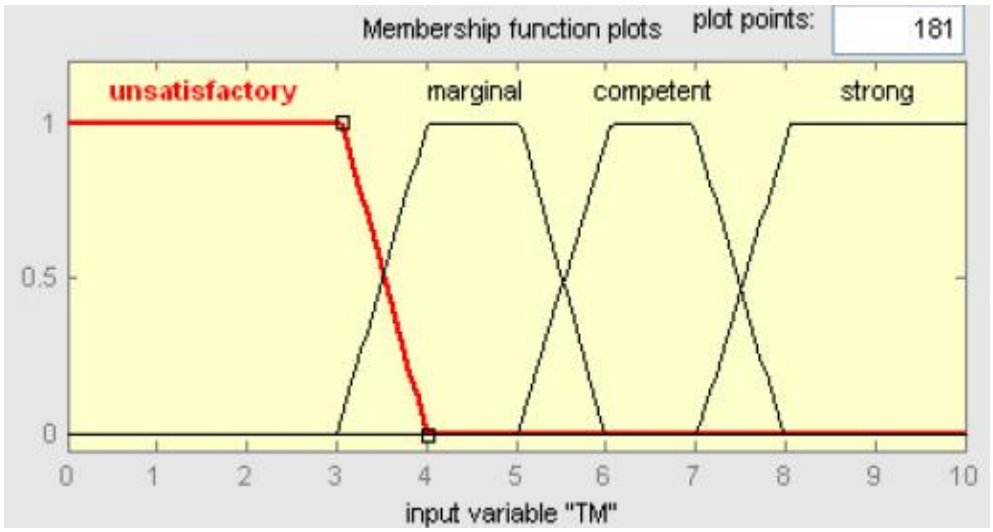


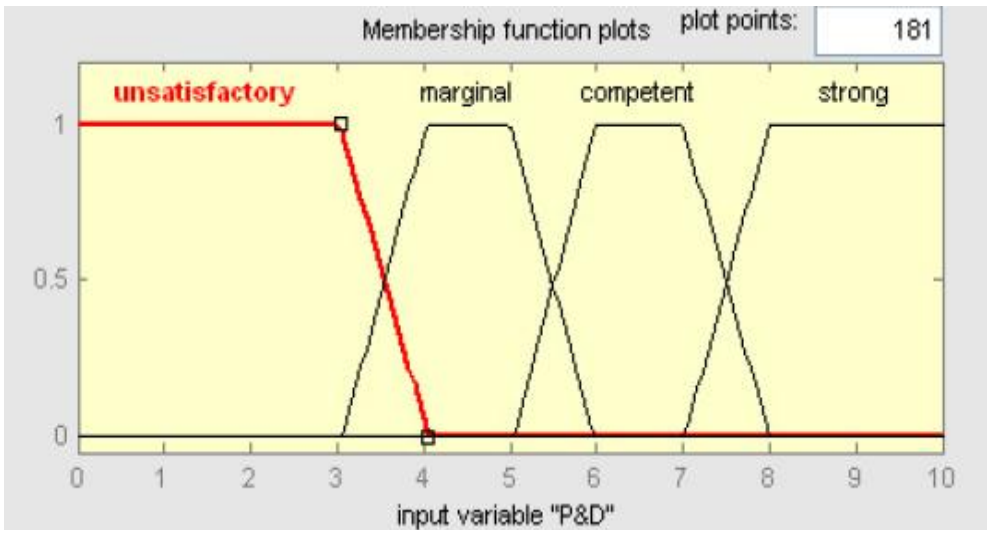
Figure 4 : Building a Fuzzy Model



Degree of Membership

Teaching Methodology

Figure 5: range and classes of Teaching Method



Degree of membership

Presentation and Delivery

Figure 6: range and classes of Presentation and Delivery

Degree of membership

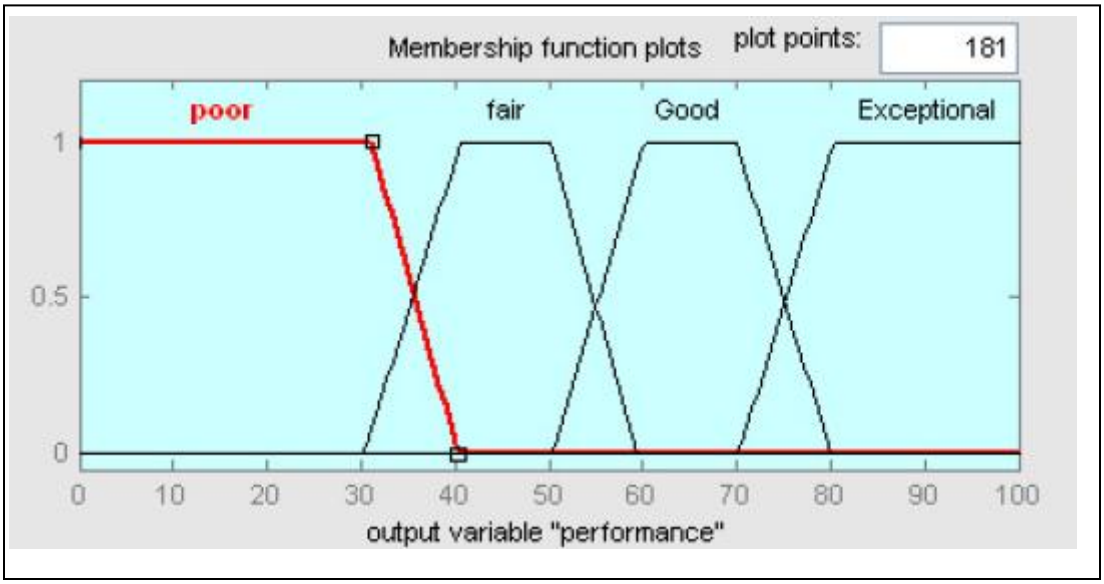


Figure 7: range and classes of Performance

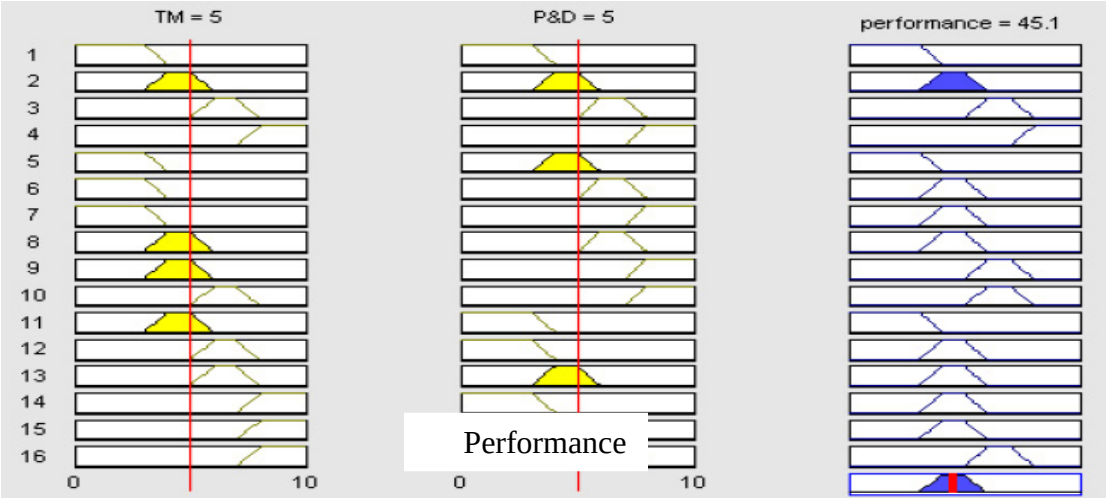


Figure 8: Mamdani methods for computing output

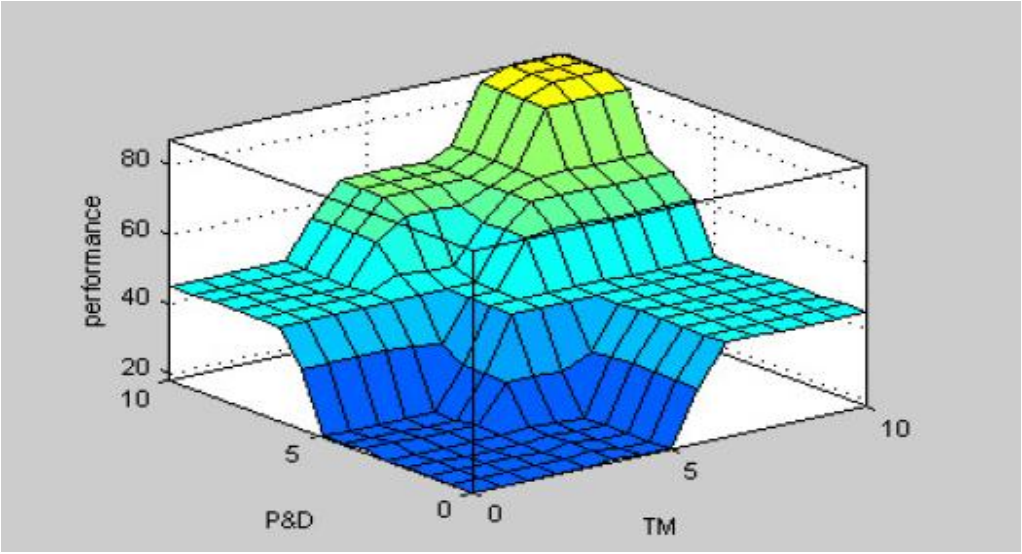


Figure 9: Three Dimensional Depiction of the inference rules

References

Baba, F. A., Cin, M.F and Diden B.(2009). " A Fuzzy system for Evaluating Students project in Engineering Education" *Willey Periodical* ,

Chattergi, M. (2003)." designing and using tools for Educational Assesment" Pearson Education.

Cunningham, G. K.(1986). "Educational and Psychological measurement" Macmillan Publishers.

Dubois, D, and Prade, H. (1997). " Fuzzy citeria and Fuzzy rules in subjective Evaluation- a general discussion" In proceedings of 5th European Congress On Intelligent Technologies and Soft computing" pp: 975-978.

Figurieira J, Greco, S. and Ehrgott. (2005)"Multiple citeria decision analysis: State of the art survey" Springer International series.

Kaliszevski, I. (2006.)" Soft Computing for Multiple citeria decision making" Springer,

Kai, M. T. (2008). On the use of fuzzy inference techniques in assessment models: part

I - theoretical properties. Fuzzy Optim Decision making, Springer Science. **7:** 269-281

Kay, M.K. Lim, C.P and The C. S. (2005). " Fuzzy Rule Base Assessment Models: Theoretical Analyses and a Case Study" IEEE

Manhat, N.(2004) ." Risk Assessment in Fuzzy Business- Fuzzy Logic provides the way to Assess off-site risk from Industrial Installations: A technical paper" Bechtel Corporation.

Lilly, Li. Huey, Lee.(2007). "A Fuzzy Assessment Model for Evaluating the rate of agreesive Risk in software Sevelopment" International Journal of computers, Issue 3, vol 1,

Nolan, J. R. (1998.) " A prototype Application of Fuzzy logic and Expert systems in educational Assessment" Proceedings of American Association for Artificial Intelligience. Triantaphyllao, E.(2000) " Multicriteria Decision making Method: a comparative Study" Kluwer Academic Publishers.

Vanstone, W. henderson K.(2003) "Nationwide implementation of global assessment of functioning as an indicator of patient secerity and services. Review of Psychiatry., 22, pp 131-153.

www.brighthub.com, 2010

Xinhua, H. Wenfa, H. (2008.)." Multi- Objective Fuzzy assessment model for selecting shipping operation organization. IEEE.

Zadeh, L. (1997). Neuro-fuzzy and soft Computing: A conceptual approach to learning and machine intelligence. Upper Saddle River NJ, Prentice Hall

Zhu, C. Li, L. (2009.)" Fuzzy Neural Network Model and its Application in Teaching Quality Evaluation" International Symposium on Intelligent

.