Application of Fuzzy Logic in Academic Setup

Parshuram Sahoo[1] Anjali sahu3, Swagatika dash,4

Department of Mathematics, Gandhi Institute For Technology, Bhubaneswar, Odisha-752054, India
Gandhi Engineering College, BBSR, Odisha.

Abstract: *In past fuzzy logic has been used mostly for classification and control. In electrical engineering to deal with such problems, fuzzy logic use for control of Rotary cranes, hybrid system controller and vector control method has been optimized by using fuzzy controller, Multi factorial Fuzzy Approach for the Assessment of Ground water Quality. Fuzzy logic has been used with great success to control machines and consumer product. Fuzzy logic is not the answer of all technical problems but for control problem so in this paper we have been use fuzzy logic in academic setup in which we deal with logical variables if age is a variable and we say 60 years age person is old. Is age of 59 years and 3 month person is young? Such type of problems we can solve by using fuzzy logic technique and fuzzy logic is best one with dealing of such variables, And we discuss Fuzzy logic technique, and why this is important for some logical variables and we take a issue of academic performance of students, many variables have effect on students performance (GPA) but we discuss only such variables where fuzzy logic is required, and these variables are previous marks, study timing and their final GPA. We have estimate student GPA at any point by using fuzzy logic with the help of fuzzy rules based on information of previous marks and study timing.*

I. Introduction

Why concept of fuzzy logic is required. In everyday life most of problems involved imprecise concept and order to handle the imprecise concepts, the conventional methods of set theory and numbers are insufficient and need to be some other concept and fuzzy logic is one of the concepts for this purpose.

Fuzzy logic systems are widely used for control, system identification and pattern recognition, but in this paper we use fuzzy logic for social variables, such variables which a computer can't explain better. Computers are very well known for counting numbers, applying various arithmetic operations, like multiply, division, subtraction also use for reasoning and also for detecting reasons. Detecting reasoning in which case either given values are true or false but truth values are given. In our daily life we have a lot of concert. That we have humans can easily describe, understand and explain to others but traditional mathematics including the set theory, fails to handle in a rational way, the concept "young" is an example for any specific person his/her age is precise. However, relating a particular age to "young" involves fuzziness and is sometimes confusing and difficult. What age is young and what age in not?

The nature of such question is deterministic and has nothing to do with stochastic concepts such as probability or possibility. Why is it that a 34.9 year old person is completely "young" while a 35.1 year old person is not "young" at all? Fuzzy logic is a new way of express the probability. Fuzzy logic is specifically designed to deal with imprecision of facts.

Prof. Manohar Lal says, fuzzy logic handles this type of variables for example "a healthy person" if we say a person is depress, so there are no. of reasons, and degree of depress is again a variable so depression is not something which can be deterministic, we take a example of everyday Old and Young, now we can't say person is old on a particular age, we can't say a person is young at 25 year old and next day he will be old, never. And he says how language can vary? Dinosaurs lived at the earth for a long period (about millions of years). It has not rained for a long period (say about six month). I had to wait for the doctor for a long period (about six hours). So how much variation in period representation by fuzzy logic we make a computer precise for these types of words.

The concept of Fuzzy Logic (FL) was conceived by Lotfi Zadeh, a professor at the University of California at Berkley, and presented not as a control methodology, but as a way of processing data by allowing partial set membership rather than crisp set membership or non-membership. This approach to set theory was not applied to control systems until the 70's due to insufficient small-computer capability prior to that time. Professor Zadeh reasoned that people do not require precise, numerical information input, and yet they are capable of highly adaptive control. If feedback controllers could be programmed to accept noisy, imprecise input, they would be much more effective and perhaps easier to implement.

Fuzzy logic deals with uncertainty in engineering by attaching degree of certain to the answer to logical questions. Commercially fuzzy logic has been used with great success to control machines and consumer products, fuzzy logic systems are simple to design, can be understood and implemented by non-specialist in control theory. Fuzzy logic is not the solution of all technical problems but for speed of implementation is

important then fuzzy logic is useful technique. [JamesVernon]

M. Hellmann **says** Basically, Fuzzy Logic (FL) is a multivalued logic that allows intermediate values to be defined between conventional evaluations like true/false, yes/no, high/low, etc. Notions like rather tall or very fast can be formulated mathematically and processed by Computers in order to apply a more human-like way of thinking in the programming of computers. Fuzzy systems are an alternative to traditional notions of set membership and logic that has its origins in ancient Greekphilosophy.

Lotfi Zadeh says fuzzy logic is not the waves of the future. It is now! There are already hundreds of millions of dollars of successful, fuzzy logic based commercial products, everything from self-focusing cameras to washing machines that adjust themselves according to how dirty the clothes are, automobile engine controls, anti-lock braking systems, color-film developing systems, subway control systems and computer programs trading successfully in the financial markets.

Fuzzy logic was conceived by Steven D. Kachler as a better method for sorting and handling data but has proven to be a excellent choice for many control system applications since it mimics human control logic. It can be built into anything from small, hand-held products to large computerized process control systems. It uses an imprecise but very descriptive language to deal with input data more like a human operator. It is very robust and forgiving of operator and data input and often works when first implemented with little or no tuning.
Fuzzy logic is also use for dealing with complicated systems in simple way, and it is also possible for classification.

Ricketts, J.H.1 (July 2009) defined fuzzy rule base system and in which he discussMumdani fuzzy knowledge rule system. He says, people are required to make trip- scheduling decisions in their daily lives. They deal with a rich set of uncertainties – changes of venue, priority, and time of activities – choices in mode, route, and time of trips – information horizons – delays and changes in current activities, and in trips. Populations both evolve and contain a rich set of applicable strategies. And rule based system is also used for both to explain and predict responses of population or individuals and they can be constructed by human experts or by machine learning techniques.

Fuzzy logic is useful for modeling inference under imprecision and fuzzy logic can be used in a rule-based system. One system is a Mamdani Fuzzy Rule Based System (FRBS) with a database and a rule-base, and these have been previously adapted to classification problems although mostly using the Michigan approach (Cordon et al. 2004)

Miroslav Hudec and Mirko Vujosevic works on selection and classification of statistical data using fuzzy logic. And he defined two often used processes are data selection (database queries) and data classification and situations when classical {true, false} logic is not adequate in these two processes and offers fuzzy logic because the fuzzy logic is an approach to computing based on "degrees of truth" rather than the usual "true or false" logic. Fuzzy approach is suitable for statistical databases. Linguistic expressions like: high rate of unemployment or medium migration level etc., are very often used and it is useful to catch them and use in database queries and classification.

Ravi. Jain and Ajith. Abraham works on (A Comparative Study of Fuzzy Classification Methods on Breast Cancer Data) and in which they examine the performance of four fuzzy rule generation methods on Wisconsin breast cancer data. The first method generates fuzzy if-then rules using the mean and the standard deviation of attribute values. The second approach generates fuzzy if-then rules using the histogram of attributes values. The third procedure generates fuzzy if-then rules with certainty of each attribute into homogeneous fuzzy sets. In the fourth approach, only overlapping areas are partitioned. The first two approaches generate a single fuzzy if-then rule for each class by specifying the membership function of each antecedent fuzzy set using the information about attribute values of training patterns. The other two approaches are based on fuzzy grids with homogeneous fuzzy partitions of each attribute. The performance of each approach is evaluated on breast cancer datasets.

Salah Bouhouche et al. (2007) published a study based on **"**Quality Monitoring Using Principal Component Analysis and Fuzzy Logic Application in Continuous Casting Process "and in which they deal with non linear system monitoring, based on a combined use of Principal Components Analysis (PCA) and fuzzy logic to process and quality monitoring. In which fuzzy logic was used to estimate the fault or defect according to the dynamic changes in the process inputs –outputs characterized by T2 Hoteling and Squared Prediction Error(SPE).

The motivation for fuzzy logic was expressed by Zadeh (1984) in the following way: "The ability of the human mind to reason in fuzzy terms is actually of a great advantage. Even though a tremendous amount of information is presented to the human senses in a given situation – an amount that would choke a typical computer – somehow the human mind has the ability to discard most of this information and to concentrate only on the information that is task relevant. This ability of the human mind to deal only with the information that is task relevant is connected with its possibility to process fuzzy information. By concentrating only on the task-relevant information, the amount of information the brain has to deal with is reduced to a manageable level.

H.Chris Tseng (2007) defined many internet applications need to deal with large amount of data collected from non-technical users and is imprecise and incomplete in nature. Well structured rules are hardly available in general applications and the nature and the pattern of the users can never be fully accounted. Soft computing techniques like fuzzy logic ideal for coping with this type of problems. And H.Chris Tseng defined fuzzy logic, the ability to model imprecise and qualitative knowledge and handle uncertainty are distinguished characteristics of fuzzy sets. Fuzzy logic is capable of addressing approximate or vague notions that are inherent in many information retrieval (IR)tasks.

Mostly on high level or university level some variables effect on students GPA. In which study timing, attendance, previous degree marks etc are effected variables. And these variables are logical variable, if we want to observe these variables affect and we categories these variable for easy interpretation, suppose we say if study timing is 5 hr then GPA is low and between 5 hr and 8 hr GPA is average and if timing is above 10 hr then GPA would be high. But logically it is not right because if study timing is 4 hr and 59 minutes so GPA is low and if study timing is 5 hr and 1 minute so GPA is average. By this means only 2 minutes low GPA convert into average. Here we want different GPA on different timing, because 2 minutes effect convert GPA low to average .Computer have not sense of such output, but human can understand such type of variables. Similarly other variables have this type of problem. For this type of problem we use fuzzy logic technique because it allows us a naturaldescription.

II. Material And Methods

Logical variables:

In our data we have many variables, such variables that a human can better understand. And we have many variables that have effect on Academic performance of students in university. Here we take two input variables study hour and previous degree marks and output is GPA. Now we make a fuzzy inference system. Fuzzy inference system is a process of mapping from given input to an output by using fuzzy logic. There are five primary GUI tools for building fuzzy inference systems in the Fuzzy Logic Toolbox: the Fuzzy Inference System or FIS Editor, the Membership Function Editor, the Rule Editor, the Rule Viewer, and the Surface Viewer.

So firstly we make FIS Editor, The first step is to take the inputs and determine the degree to which they belong to each of the appropriate fuzzy sets via membership functions. The input is always a crisp numerical value and the output is a fuzzy degree of membership (always in interval between 0 and 1).
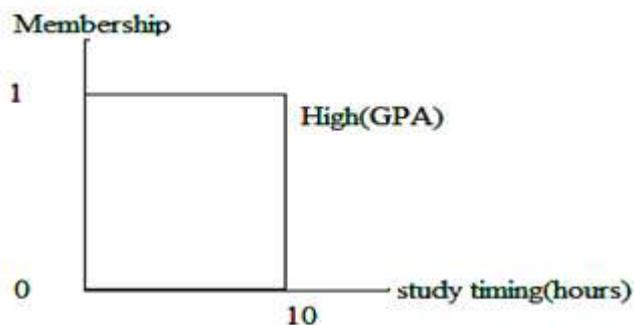
We enter three variables in FIS editor in which two as a input and one is output, Study hour, percentage of previous degree marks, these are input variables and GPA is output variable and computer cannot explain well, for example if answer in the form of No or Yes and we say if study hour 6 so GPA will be average. Logically questions arise if study hour are 6hr and 5 min so what would be GPA? Are GPA should be change? And, if GPA is 5 hr and 56 min so GPA will be low? So for this type of problem in fuzzy logic we make if then rules. By rule we human can determine such variables better than computer. So in this technique in each point of input we have output. On 6 hr we have output of GPA and on the point of 5 hr and 56 min wehave

FIS editor:
The FIS editor provide general information about a fuzzy inference system Fuzzy inference system (FIS):

Fuzzy inference is the actual process of mapping from a given input to an output using fuzzy logic. The process consist of all the parts that we'll discuss next i.e., fuzzy sets, membership functions, fuzzy logic operators, and if-thenrules
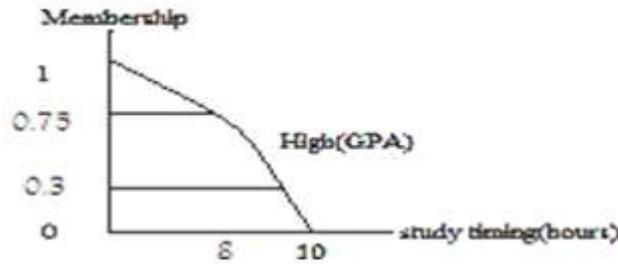Firstly we explain fuzzy sets; mostly we have two types of sets. Crisp or classical sets and fuzzy Crisp sets:

(Figure 1)

In classical set theory membership of an object is always 0 or 1.This set is not reasonable because the change on membership function at 10 (hours). Here a   fundamental problem exists, on the different hours membership value changes from 1 to 0 may beused.
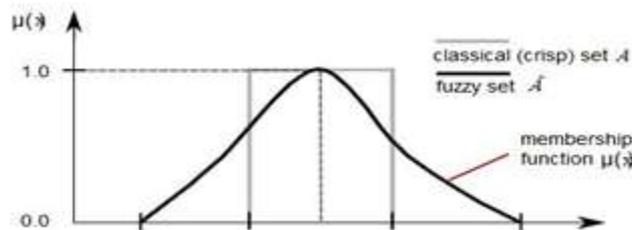
Fuzzy sets:

(Figure 2)

In fuzzy set theory membership values lies also between 0 and 1.

Membership function:

A membership function (MF) is a curve that defines how each point in the input space is mapped to a membership value (or degree of membership) between 0 and 1. and membership function is graphical representation of inputs and output. In which our fuzzy sets have different properties and membership functions represents the degree of truth. And peak of distribution shown in (figure: 3) shows the highest degree means close to 1 or 1. and both tails of distribution shows smallest degree close to 0 or 0.
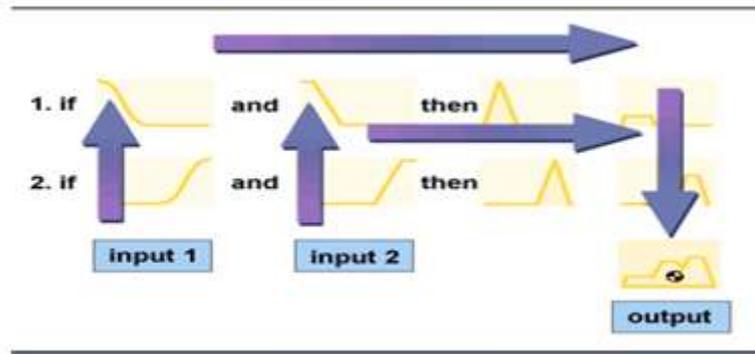

(Figure 3)

Fuzzy rules:
Fuzzy rules are the conditional statements that make fuzzy logic useful. A single fuzzy if-then rule assumes the form:
If x is A then y is B

where A and B are linguistic values defined by fuzzy sets on the ranges X and Y, respectively. The if-part of the rule "x is A" is called the antecedent or premise, while the then-part of the rule "y is B" is called the consequent or conclusion. In our study we take some rules by the help of finding of irumshehzadi 2009. In this finding our logical variables effect on students GPA but study timing is more effected then previous degree marks like this and by this information we make rules and gets final outputs.

RULES

(Figure4)

1. If study timing is low and previous marks low then GPA islow
2. If study timing is average and previous marks low then GPA islow
3. If study timing is high and previous marks low then GPA isaverage
4. If study timing is low and previous marks average then GPA isaverage
5. If study timing is average and previous marks average then GPA isaverage
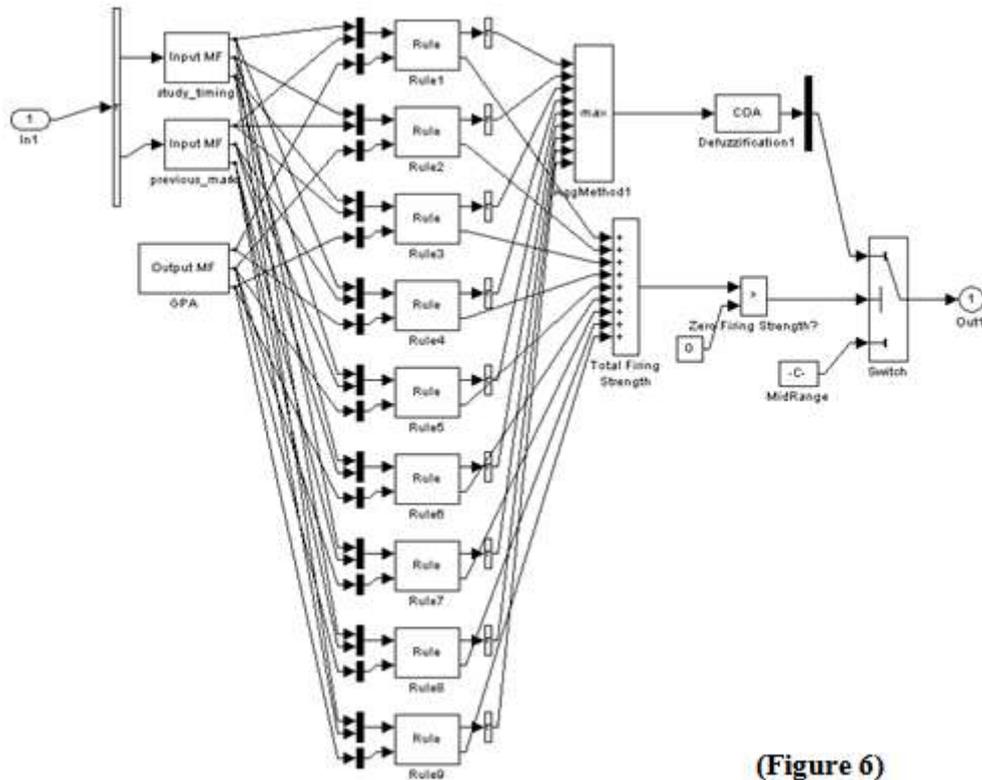6. If study timing is high and previous marks average then GPA ishigh
7. If study timing is low and previous marks high then GPA isaverage
8. If study timing is average and previous marks high then GPA ishigh
9. If study timing is high and previous marks high then GPA ishigh

Simulation:

      We can evaluate our FIS performance by using fuzzy logic controller block (figure: 5) in simulink model. The Fuzzy Logic Controller block generates a hierarchical block diagram that represents our fuzzy inference systems. Simulink is a control library which allows easy implementation of any control algorithm, including linear control, fuzzy logic, neural networks, etc.

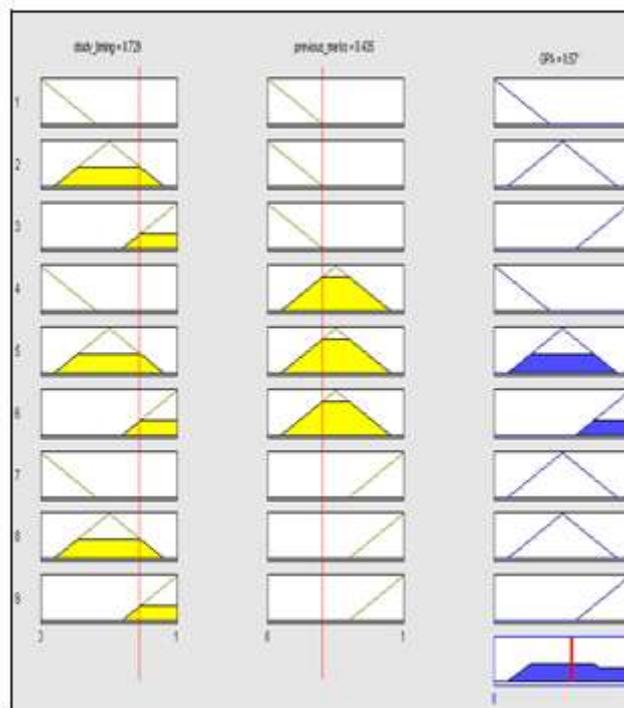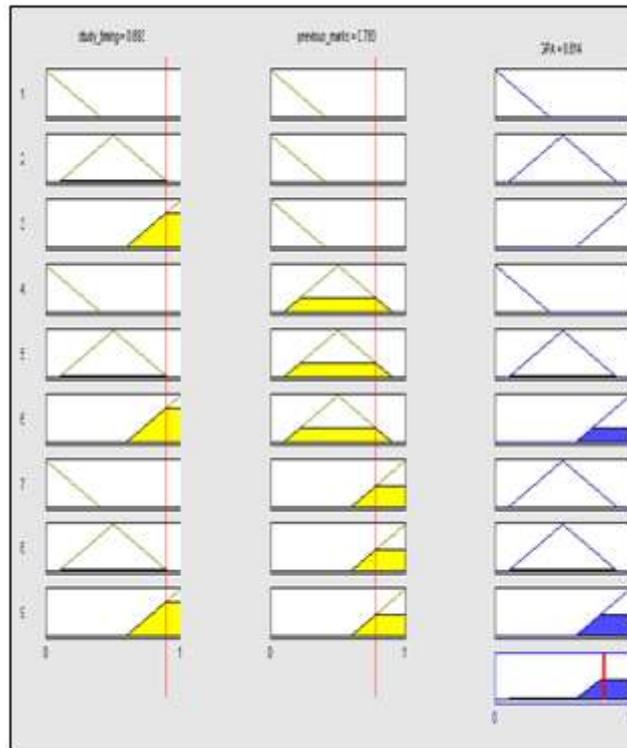**(Figure 5)**

Fuzzy Logic Library

      In (Figure 6) this simulink block use for evaluation of FIS and this block shows us how our rules attach with our inputs and output and after defuzzification gives us a single value output and by moving the both inputs we find a change output similarly each point of input we can find output value.
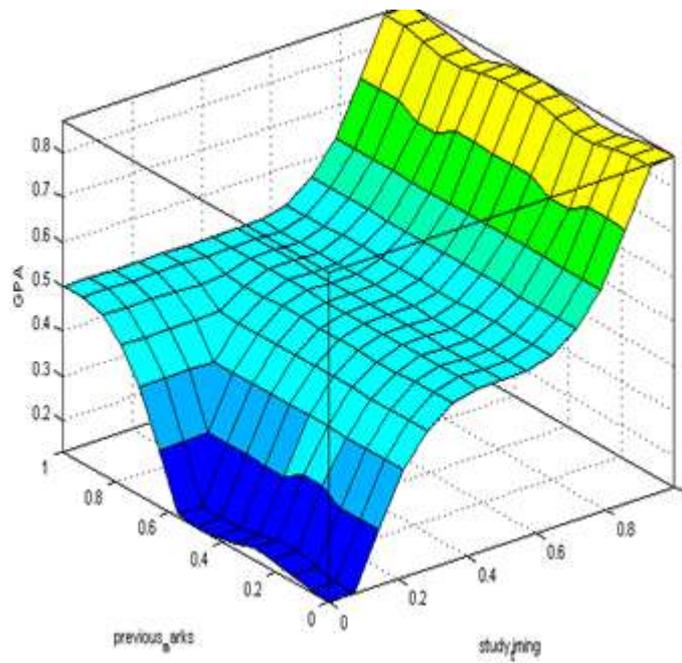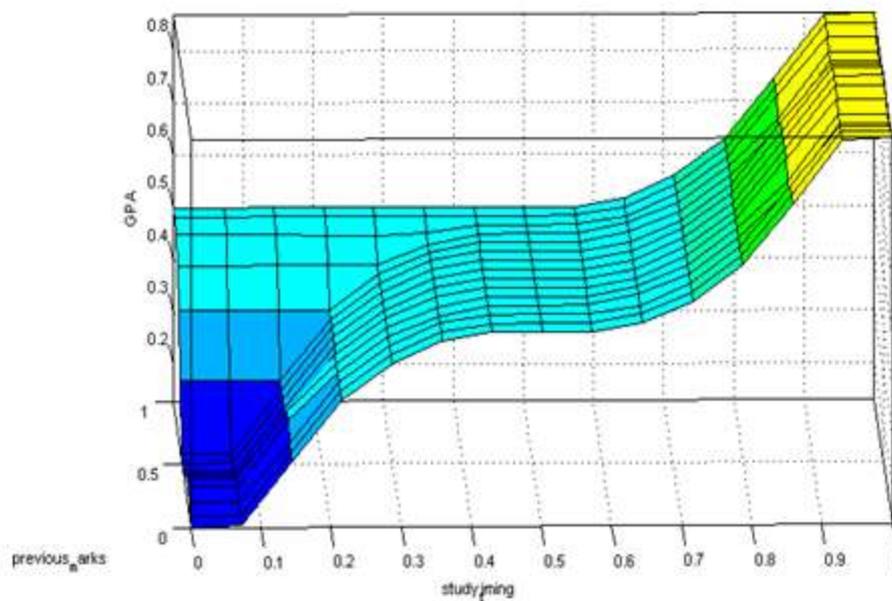
(Figure 6)

III. Results And Discussion

(Figure 7)

(Figure 8)

In Figure 8, we generate 3-D surface from two inputs and one output. we can see that where lower marks and low timing then GPA is low and average and by increasing the study timing our GPA increase and move up to yellow colure where GPA high. And these all points combine by the information of rules and by changing each point we can find a different output. By this we can find weight of inputsvariable.

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