

Introduction

The primary objective of this project is to understand the real-world applications of fuzzy systems. Fuzzy systems are control systems based on fuzzy logic, their applications are extremely vast; with uses from microcontroller based fuzzy logic ^[1] to fuzzy logic antilock braking systems ^[2]. The primary reason for the vast popularity of fuzzy logic systems is its flexibility. Fuzzy logic is a technique so powerful that it can be used to solve almost any control problem.

Fuzzy logic helps solve problems that are difficult with traditional control techniques, this is because of its ability to handle 'non-perfect logic'. This means that while a traditional logic system must receive inputs that are expressed as 'true' and 'false', a fuzzy logic system can deal with concepts that are 'half-true' or 'partially-true'. This gives fuzzy logic the advantage over traditional methods.

This document outlines an attempt to develop an efficient marriage compatibility system as a fuzzy logic expert system.

Problem

As mentioned above, Fuzzy logic helps solve problems that are difficult with traditional control techniques, this is because of its ability to handle 'non-perfect logic'. The saying, "No one is perfect", has been consistently been used said by people. In this case, it's finding your compatible partner. There are many people in this world looking for love, but it's not always easy to find your match. There are many characteristics describing a person, which involve Personal Character, Education Level, Financial Standing, Beauty, and Previous History. A marriage compatibility system using fuzzy logic expert system will help find one's match.

Method

Linguistic Variables

This fuzzy system has five linguistic variables: Personal Character, Education Level, Financial Standing, Beauty, and Previous History. While we did not come up with the variables, these variables fit our fuzzy system very well. Personal character is very important when it comes to marriage compatibility, because it defines the wholeness of a person's integrity and morals. Ralph Waldo Emerson, a 19th century American poet defined personal character as "Personal character is higher than intellect". This is precisely why we have weighted Personal Character higher than Education Level in our system, more on this will be explained later in the report. Education Level and Financial Standing are also very important because it helps describe their intellect and past decisions. Beauty is an obvious linguistic variable because it is the first characteristic of a person that people first see. Beauty is the aesthetic pleasure of satisfaction a person delivers and it often some people's primary factor in determining a mate. Lastly, Personal History helps determine one's familiarity to a person, a high level of personal history denotes a close or childhood friend; one that can be relied on and trusted. All these linguistic variables are

crucial when determining a marriage candidate.

Determining Fuzzy Sets

To determine the fuzzy sets we analyzed each of the previously mentioned linguistic variables to devise the most appropriate attributes. For example, to determine the attributes for Personal Character we decided to pick what we thought was the most important personal characteristic, and make that into a scale. We decided to pick 'nice' and make a varying scale of niceness. For education level we decided to scale different levels of education completed; no education completed, high school completed, post-secondary education, masters, or doctorate.

Education level is a good estimate of a person's intellect, which is very important in a marriage candidate. Financial Standing and Beauty were done similarly, we simply picked scaled them in scales of financial standing and beauty. Previous History was a little bit more challenging because of the ambiguity of the variable's name, but in the end we decided to go with our current scale of: stranger, friend of a friend, friend, good friend, and childhood friend.

Table 1: Variables used to describe the individual

Personal Character (PC)	Education Level (EL)	Financial Standing (FS)	Beauty (B)	Previous History (PH)
Not Nice	No Education	Broke	Hideous	Total Stranger
Somewhat Nice	High School	Poor	Ugly	Friend of a Friend
Nice	Diploma Or Degree	Average	Average	Friend
Very Nice	Masters	Prosperous	Cute	Good Friend
Extremely Nice	Doctorate	Rich	Beautiful	Childhood Friend

Fuzzy Rules

For ease of use and writing, let us use the following notation:

- 1 - Lowest value for any input (Far left MF)
- 2 - Second Lowest value for any input (Left MF)
- 3 - Middle value for any input (Middle MF)
- 4 - Second Highest value for any input (Right MF)
- 5 - Highest value for any input (Far Right MF)

Example: A value of 1 for Personal Character (PC) would correspond to 'Not Nice', which a 4 would denote a 'Very Nice'.

M – output of the fuzzy system, the marriage compatibility

Table 2: Fuzzy Rules

Rule	PC	EL	FS	B	PH	M	Rule	PC	EL	FS	B	PH	M
1	1	0	0	0	0	1	14	0	0	4	0	0	4
2	2	0	0	0	0	2	15	0	0	5	0	0	5
3	3	0	0	0	0	3	16	0	0	0	1	0	1
4	4	0	0	0	0	4	17	0	0	0	2	0	2
5	5	0	0	0	0	5	18	0	0	0	3	0	3
6	0	1	0	0	0	1	19	0	0	0	4	0	4
7	0	2	0	0	0	2	20	0	0	0	5	0	5
8	0	3	0	0	0	3	21	0	0	0	0	1	1
9	0	4	0	0	0	4	22	0	0	0	0	2	2
10	0	5	0	0	0	5	23	0	0	0	0	3	3
11	0	0	1	0	0	1	24	0	0	0	0	4	4
12	0	0	2	0	0	2	25	0	0	0	0	5	5
13	0	0	3	0	0	3							

Designing Fuzzy Rules

The fuzzy rules in this system are not combination, but rather they are all 'singular'. For example, a combinational rule would encompass various linguistic variables in its rule, whereas a singular rule would only use one linguistic variable at a time.

If (PersonalCharacter is NotNice) then (MarriageScore is NeverInAMillionYears)

Above is an example of a singular rule, below is a combination rule.

If (PersonalCharacter is NotNice) AND (EducationLevel is NoEducation) then (MarriageScore is NeverInAMillionYears)

This technique for developing rules ensures a loosely guided fuzzy system, in other words there is very little guidance for the system. If one were to use a large number of

combinational rules, the fuzzy system would lose its ‘fuzziness’ and would depend too heavily on the rules. To avoid this, we decided to only use singular rules.

Tuning the System

Initially we were using 100 combinational rules in our fuzzy system because we felt that it would provide a more accurate answer, but after initial testing we realized our mistake. The large number of rules couples with the fact that they were combinational had made our system too strict and rigid, with the system relying too heavily on the rules. This mean we would never fully utilize the fuzzy aspect of the fuzzy system, this failing to reach the objective of the problem. Realizing our mistake we quickly scrapped all the rules and started over, aiming to use only singular rules.

After the 25 singular rules were implemented, we still weren't done. After a little more testing we realized that while our system was indeed fuzzy, it was too generic, too bland. This was because we lacked weights in our system, without it every linguistic variable was treated equally. We needed the system to conform to our standards, so we decided that we would sit down as a team and decide on a hierarchy for the five linguistic variables. With this hierarchy we could add weights to the rules, thereby giving more importance to characteristics that we feel were crucial.

Below is the weights we came up with for each of the linguistic variables.

Table 3: Linguistic Variables

Personal Character	0.7
Education Level	0.5
Financial Standing	0.8
Beauty	0.6
Previous History	0.3

Since we use singular rules that encompass every possible characteristic of the linguistic variables, we assign one of the above weights to every rule. For example, all Personal Character rules will get a weight of 0.7, all Education Level rules have a weight of 0.5, and so on. This last change ended up being the final step in the construction of our system.

Test Cases

Test Case #1

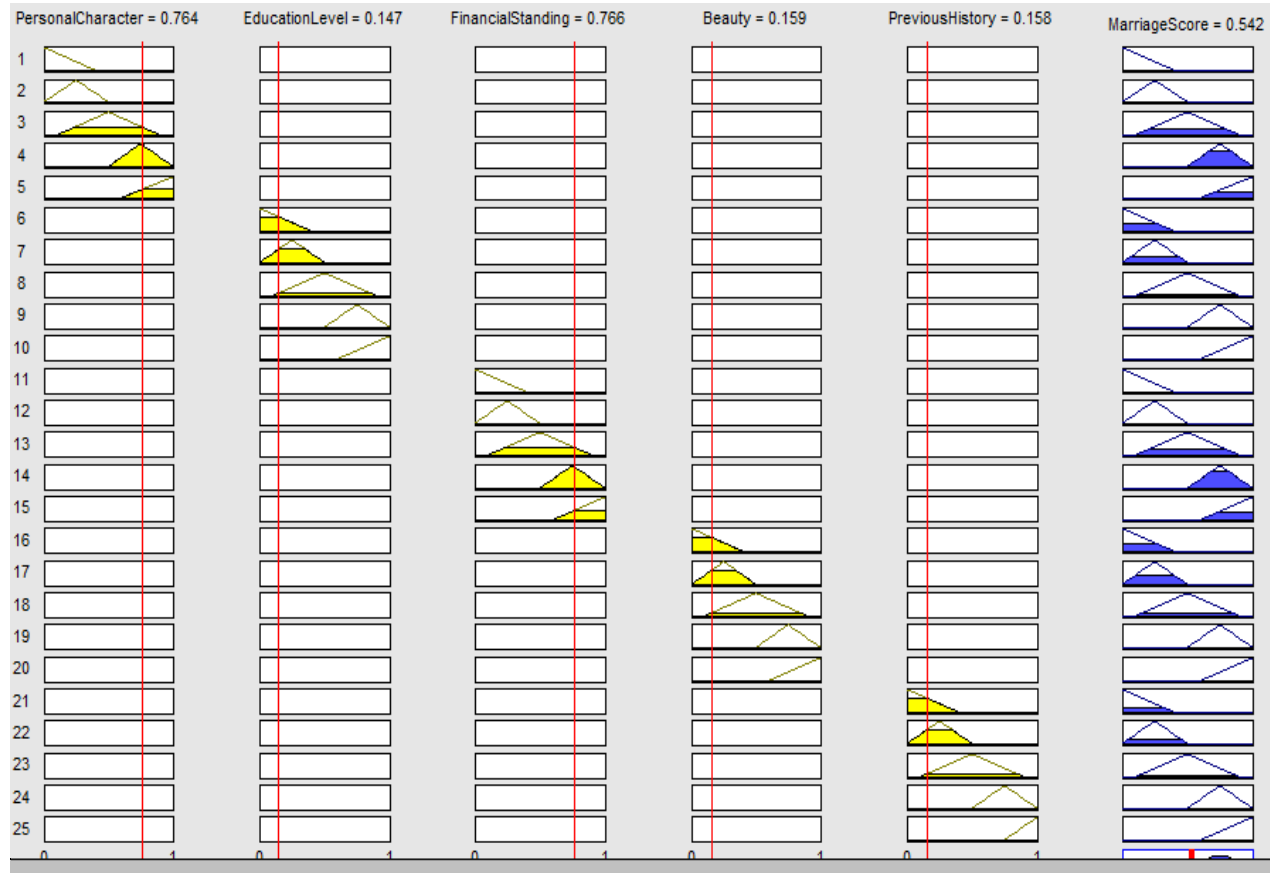


Figure 1: Test Case 1

In this test case we inputted high values for PersonalCharacter and FinancialStanding, 0.764 and 0.766 respectively, and low values for the rest of them, less than 0.2. Normally on a generic system the output value, the marriage compatibility, would be fairly low (0.3988 with equal weights). But since we're putting more importance on the PersonalCharacter and FinancialStanding, they pull up the output value up to 0.542. This means that our fuzzy system works well, taking into account our personal tastes when calculating the compatibility. The results are listed above.

Test Case #2

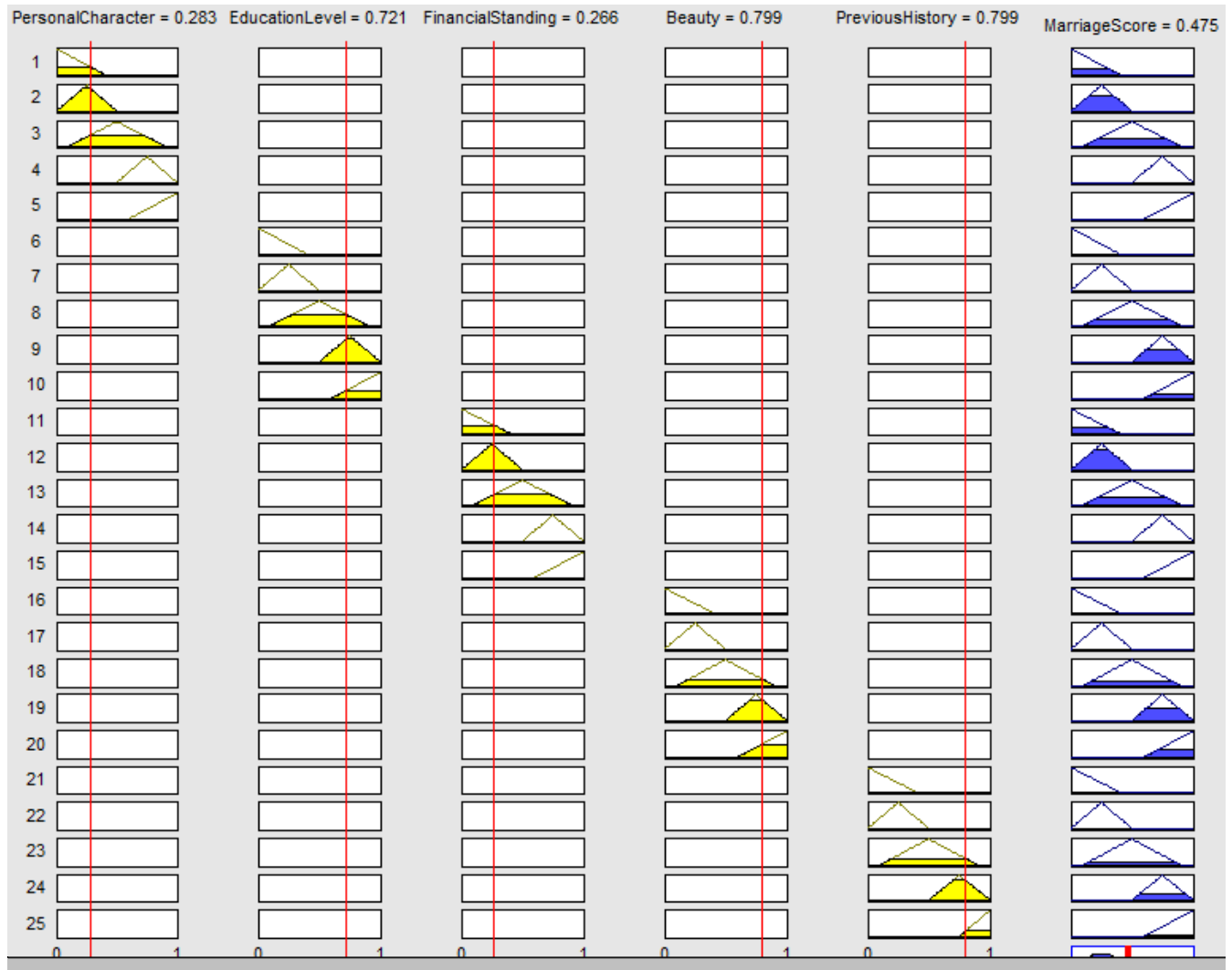


Figure 1: Test Case 1

This test case outlines a result that is somewhat opposite to the one before. In this test case the PersonalCharacter and FinancialStanding are set to low, while the the rest of the linguistic variables are set to high. Despite this, the rest of the final score is low because of the weight of PersonalCharacter and FinancialStanding. This test case shows that our system is working appropriately.

Conclusion

After developing the linguistic variables, determining the fuzzy sets, constructing the rules, and

finally testing the system, we are sure that our system works well. This means that anyone looking for a potential marriage candidate can use this system and expect good results.

Bibliography

[1] <http://www.meeting.edu.cn/meeting/UploadPapers/1282790106328.pdf>

[2] <http://www.biblioteca.uma.es/bbl/doc/tesisuma/16610301.pdf>