Fuzzy Logic Based Grading System for Student Projects Using Quality Attributes

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***Abstract*-Fuzzy approach is based on premise that the key elements in human thinking are not just numbers. Decision maker's response to the different alternatives and also preferences to the various attributes may be sometimes expressed in linguistic variables.**

I. INTRODUCTION: FUZZY LOGIC:

Fuzzy logic is branch of logic specially designed for representing knowledge and human reasoning in such a way that it amenable to processing by a computer. Fuzziness pertains to uncertainty associated with a system i.e. the fact that nothing can be predicted with exact precision. Fuzziness is property of language. Its main source is the imprecision in defining and using symbol. A fuzzy set is a collection of distinct elements with a varying degree of relevance or inclusion. There are two commonly used ways of denoting fuzzy sets.

First,

If X is the universe of discourse and x is a particular element of X, then a fuzzy set A defined on X may be written as a collection of ordered pairs:

$$A = \{(x,\mu_A(A))\},\ x \in X$$

Where each pair $(x,\mu_A(A))$ is called a singleton, where x is followed by its membership function $\mu_A(A))$.

Second,

Singleton can also be written as $\mu_A(x)/x$ and fuzzy set A can also be represented as,

$$A = \sum_{xi} xi/\mu A(xi)$$

Membership function also known as characteristic function can take value between 0 and 1 and indicates degree of membership. Since there are infinite numbers between 0 and 1, infinite degrees of membership are possible.

Fuzzy approach is based on premise that the key elements in human thinking are not just numbers. Decision maker's response to the different alternatives and also preferences to the various attributes may be sometimes expressed in linguistic variables.

II. THE STUDENT PROJECT EVALUATION PROBLEM

For project evaluation generally a panel of experts is created. Students show their project with project report and power point presentation. Experts judge the project on different aspects such as project goal and area, functionality, project report documentation etc. and give their opinion linguistically as excellent, very good, good or average or bad. Their opinion is then combined for grading the project. It is difficult to quantify these linguistic opinions, then combining them and deciding the grade. Fuzzy logic may serve this purpose very effectively and efficiently.

III. APPLYING FUZZY LOGIC FOR PROJECT EVALUATION

Here a generalized fuzzy decision system for project evaluation is modeled and solved. For this first a set of project attributes and their possible opinion linguistic terms are selected. A fuzzy decision set is formed which indicate expert opinion for each project attributes. Fuzzy set is then defined for each attribute. A fuzzy subset is formed for all linguistic terms.

A panel of experts is formed for project evaluation. Students present their project with a demo of their running project, power point presentation and a project report. Experts give their opinion using any of the possible linguistic terms for each of the project attribute. For example **power point presentation** can be ***Excellent, Very good, Good, Average, Fair or Bad***. Similarly **modularity** can be ***High, Medium, Low, Very low or Nil***.

A. *The attributes*

For illustration following six attributes and considerable corresponding linguistic terms are selected for project evaluation:

1. **Documentation**
    1. **Excellent(E)**
    2. **Very Good(VG)**
    3. **Satisfying(S)**
    4. **Moderate(D)**
    5. **Limited(L)**
    6. **Bad (B)**
2. **Presentation**
    1. **Excellent(E)**
    2. **Very good(VG)**
    3. **Good(G)**
    4. **Average(AV)**
    5. **Fair(F)**
    6. **Bad(B)**
3. **Security/Authentication**
    1. **Excellent(E)**
    2. **Very good(VG)**
    3. **Good(G)**
    4. **Average(AV)**
    5. **Fair(F)**
    6. **Bad(B)**
4. **Functionality**
    1. **Excellent(E)**
    2. **Very good(VG)**
    3. **Good(G)**
    4. **Average(AV)**
    5. **Fair(F)**
    6. **Bad(B)**
5. **Modularity**
    1. **Very High(VH)**
    2. **High(H)**
    3. **Medium(M)**
    4. **Low(L)**
    5. **Very low(VL)**
    6. **Nil (N)**
6. **Design of user interface**
    1. **Excellent(E)**
    2. **Very good(VG)**
    3. **Good(G)**
    4. **Average(AV)**
    5. **Fair(F)**
    6. **Bad(B)**

B. The Fuzzy Subset

Fuzzy subset representation for various project features is as follows:

Documentation

1. **Excellent(E):** 1/1.0 + 2/0.8 + 3/0.6 + 4/0.4 + 5/0.2 + 6/0.0
2. **Good(G):** 1/0.8 + 2/1.0 + 3/0.8 + 4/0.6 + 5/0.4 + 6/0.2
3. **Satisfying(S): 1/0.6 +** 2/0.8 + 3/1.0 + 4/0.8 + 5/ 0.6 + 6/0.4
4. **Moderate(M):** 1/0.4 + 2/0.6 + 3/0.8 + 4/1.0 + 5/0.8 + 6/0.6
5. **Limited(L):** 1/0.2 + 2/0.4 +3/0.6 + 4/0.8 + 5/1.0 + 6/ 0.8
6. **Bad(B):** 1/0.0 + 2/0.2 + 3/0.4 + 4/0.6 + 5/0.8 + 6/1.0

Presentation, Security/Authentication, Functionality, Design of User Interface

1. **Excellent(E):** 1/1.0 + 2/0.8 + 3/0.6 + 4/0.4 + 5/0.2 + 6/0.0
2. **Very good(VG):**1/0.8 + 2/1.0 + 3/0.8 + 4/0.6 + 5/0.4 + 6/0.2
3. **Good(G): 1/0.6 +** 2/0.8 + 3/1.0 + 4/0.8 + 5/ 0.6 + 6/0.4

4. **Average(AV):** 1/0.4 + 2/0.6 + 3/0.8 + 4/1.0 + 5/0.8 + 6/0.6
5. **Fair(F):** 1/0.2 + 2/0.4 +3/0.6 + 4/0.8 + 5/1.0 + 6/ 0.8
6. **Bad(B):** 1/0.0 + 2/0.2 + 3/0.4 + 4/0.6 + 5/0.8 + 6/1.0

Modularity

1. **Very High(VH):** 1/1.0 + 2/0.8 + 3/0.6 + 4/0.4 + 5/0.2 + 6/0.0
2. **High(H):** 1/0.8 + 2/1.0 + 3/0.8 + 4/0.6 + 5/0.4 + 6/0.2
3. **Medium(M): 1/0.6 +** 2/0.8 + 3/1.0 + 4/0.8 + 5/ 0.6 + 6/0.4
4. **Low(L):** 1/0.4 + 2/0.6 + 3/0.8 + 4/1.0 + 5/0.8 + 6/0.6
5. **Very Low(VL):** 1/0.2 + 2/0.4 +3/0.6 + 4/0.8 + 5/1.0 + 6/ 0.8
6. **Nil(N):** 1/0.0 + 2/0.2 + 3/0.4 + 4/0.6 + 5/0.8 + 6/1.0

C. The Ideal performance

Ideally, a student project must be best. We choose best performance as ideal performance. Hence, Fuzzy subset representations of selected attributes for ideal performance are:

1. **Documentation(E): 1/1.0 + 2/0.8 + 3/0.6 + 4/0.4 + 5/0.2 + 6/0.0**
2. **Presentation(E): 1/1.0 + 2/0.8 + 3/0.6 + 4/0.4 + 5/0.2 + 6/0.0**
3. **Security and Authentication(E):1/1.0 + 2/0.8 + 3/0.6 + 4/0.4 + 5/0.2 + 6/0.0**
4. **Functionality(E):1/1.0 + 2/0.8 + 3/0.6 + 4/0.4 + 5/0.2 + 6/0.0**
5. **Modularity(H): 1/1.0 + 2/0.8 + 3/0.6 + 4/0.4 + 5/0.2 + 6/0.0**
6. **Design of user interface(E): 1/1.0 + 2/0.8 + 3/0.6 + 4/0.4 + 5/0.2 + 6/0.0**

D. The Opinion Matrix

A panel of three experts (examiners) is formed to evaluate student projects for B.Sc.(Information Technology) students of Ranchi Women's College, Ranchi. Students were asked to present their projects using PowerPoint presentation, project report and a live demo of running project. Experts stated their opinion linguistically for each of the selected attributes. An opinion matrix is formed for each project attribute.

For demonstration of our methodology opinion about five student's project is selected. Which can be further extended for any desired number of projects. For five students, three experts' opinion about project presentation is shown as following opinion matrix.

	S1	S2	S3	S4	S5
E1	E	VG	G	AV	F
E2	VG	E	AV	F	F
E3	G	VG	G	G	AV

The overall opinion about a student project presentation can be obtained by considering the corresponding column values. Overall opinion for five students is as follows:

Student1: E^VG^G
1/0.6 + 2/ 0.8 + 3/ 0.6 + 4/ 0.4 + 5/ 0.2 + 6/0.0
Student2: VG^E^VG
1/0.2 + 2/ 0.4 + 3/ 0.6 + 4/ 0.6 + 5/ 0.4 + 6/0.2
Student3: G^AV^G
1/0.4 + 2/0.6 + 3/ 0.8 + 4/ 0.8 + 5/ 0.6 + 6/0.4
Student4: AV^F^G
1/0.2 + 2/ 0.4 + 3/ 0.6 + 4/ 0.8 + 5/0.8 + 6/0.6
Student5: F^F^AV
1/0.0 + 2/ 0.2 + 3/ 0.4 + 4/0.6 + 5/0.8 + 6/0.6

E. The Distance Matrix

Ideally, a project present should be "Excellent". For grading fuzzy hamming distance between the "Excellent" fuzzy set and opinion set is calculated for each student project using following formula,

$$d(O,E) = \sum_{i=1}^{6} |\mu o(xi) - \mu E(xi)|$$

A fuzzy distance set for all five students with respect to project presentation is given as,

	S1	S2	S3	S4	S5
F_{CS} =[	0.4	1.8	2.2	2.8	3.2]

Similarly, considering other factors fuzzy distance matrix is formed:

	S1	S2	S3	S4	S5
Documentation	0.2	1.6	2.2	2.4	2.4
Presentation	0.4	1.8	2.2	2.8	3.2
Security and Authentication	2.2	1.2	1.2	2.8	2.2
Functionality	0.4	1.2	2.4	2.8	2.8
Modularity	0.4	0.4	1.6	2.8	2.8
Design of user interface	1.2	1.2	1.6	2.8	2.2
Total	4.9	7.5	11.2	16.8	15.6

F. The Ranking And Grading

We are considering all attributes hence all the hamming distances are summed to calculate net distance **Total.** Now, the total distance can be used to rank and grade the project. As these are distances from ideal performance, hence, the minimum distance possesses best performance. We can rank these five students as follows:

1st	**2nd**	**3rd**	**4th**	**5th**
S1	**S2**	**S3**	**S5**	**S4**

For grading, we choose 6 grades

Ex: equivalent to excellent of Documentation, presentation, security, functionality and user-interface and very high of Modularity.

A^+: equivalent to very good of Documentation, presentation, security, functionality and User-interface and high of Modularity.

A: equivalent to Good of Documentation, presentation, security, functionality and User-interface and medium of Modularity

B^+: equivalent to Average of presentation, security, functionality and user-interface, satisfying of Documentation and low of Modularity.

B: equivalent to Fair of presentation, security, functionality, moderate of documentation and user-interface and very low of Modularity.

C: equivalent to Bad of Documentation, presentation, security, functionality and user-interface and Nil of Modularity.

Distance between Ex and other grades are calculated as,

	Ex	A^+	A	B^+	B	C
d:	0.0	1.2	2.0	2.8	3.2	3.6
6*d:	0.0	7.2	11.99	16.8	19.2	21.59

Now we can grade a project depending on total fuzzy distance and 6*d values as:

If **Total <7.2** then grade = **Ex**.

If **Total>=7.2 and Total<11.99** grade=**A^+.**

If **Total>=11.99 and Total<16.8** grade=**A.**

If **Total>=16.8 and Total<19.2** grade=**B^+.**

If **Total>=19.2 and Total<21.59** grade=**B.**

If **Total>=21.59** grade=**C.**

Depending on these rules the five student projects are graded as follows:

Project S1: Ex

Project S2: A^+

Project S3: A^+

Project S4: A

Project S5: A

IV. CONCLUSION

This paper presents a framework for grading of projects of students of computer science and information technology using Fuzzy Logic. Generally, in educational institutes final year students are required to build a project. For evaluation a panel of internal and external expert is formed. Students show their project with help of project report, power point presentation and demo run. At first look experts give linguistic opinion like good, bad, excellent or satisfying etc. later on they discuss and grade the project which may be a time consuming process. It may also lead to debate among experts. Also may cause certain attributes unconsidered. This paper provides a solution to this problem with use of fuzzy logic. A very general attributes(Documentation, Power point presentation, functionality, design of user interface, security/authentication and modularity) are considered. We have considered all project attribute of equal weight. The number of attributes and their weights may be changed according to requirement of educational institute wishing to use this methodology. A set of linguistic values is assigned for these attributes. We have chosen five sample projects and taken linguistic opinion of three experts for six chosen attributes. The fuzzy set is designed for each linguistic value and then these fuzzy sets are combined to rank and grade the projects.

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