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A FUZZY SOFT SOFTWARE LIFE CYCLE MODEL

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ABSTRACT

Software development is an important task in Software engineering. The selection of a suitable model over the list of all possible models available in software engineering depends on the efficiency and aptness to complete the desired project. Such a model should be able to provide the end deliverables of the project within the desired time and maximum possible throughput. The study uses a fuzzy multiple criteria decision making (FMCDM) approach for selection of a suitable software model. To select the most appropriate one the above model developed in the study is applied to five software life cycle models (SLCMs).

Key words: Software Life Cycle, Fuzzy Decision Making, Fuzzy Soft Sets.

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1. INTRODUCTION

The primary goal of software engineering is to build a model with desired efficiency and accuracy such that it can complete the project in the desired timeline and achieve the objectives that was initially laid upon. The applicability of SLCM comes at this point as a relevant SLCM is critical for meeting all the requirement of the project in its various stages. Fuzzy concepts are being largely deployed in software engineering in recent years.

There has been an increased interest in predicting the events of the future based on the data available. Two methods are available using which people can make appropriate decisions upon analyzing the past and impact on the future. The first method utilizes a direct extrapolation from the past events to predict the future. In the second method past observations are used to predict the future using various simulations. Accuracy of such a prediction can be improved using mathematical modeling where a number of variable inputs are manipulated to get a decisive output.

Fuzzy multiple Attribute Decision Making Model (FMADM) is superior to the classical multiple attribute decision making (MADM) methods as it can handle inaccurate and inefficient data better. It is being increasingly used in various areas such as Artificial Intelligence, Applied Sciences and Management. User friendly simulation models are becoming increasingly relevant in the present world where real time operations are becoming the top priority. Fuzzy logic (FL) in computer modelling simulation [1-17] are hence being widely implemented by people worldwide. Using membership functions the crisp real values are converted into fuzzy values. The fuzzy set can be applied in Economics, Psychology, Computer science, Engineering, Physics and many areas of Mathematics. The crisp real values are converted in to fuzzy values with the help of membership functions (MF). The study tries to use fuzzy soft set model in SLCM selection. The fuzzy soft set model is developed, some results on them are set forth and develop an algorithm for SLCM selection in five software life cycle models. In this paper, the model construction are introduced in section 2, experiment and result, and conclusion are included in section 3 and section 4.

1.1. Waterfall Model

The first model to come up, various phases take a linear structure progressing from analysis, design, coding, testing, implementation and finally support. The feasibility of the project is analyzed in the first step after which the tools, essentials and planning of the methodology of project is carried out. This is followed by designing process and then the coding process. Testing is done on the integrated code to rate the efficiency of the program. When all these processes are carried out successfully, the system is installed. Lack of clarity on where the various phases begin and end is a major disadvantage in this model. The model is implemented only if the system requirements are well defined and the problem domain and tool feasibility are precise.

1.2. Incremental Model

The incremental model combines waterfall model and prototyping where in each stage of the project increments are created. The first increment to be given to the customer for use or review is the core product without any improvement. The product is then analyzed and the new requirements are taken into consideration to develop a plan. During evaluation or application by the customer, new increments are added if necessary to make the software more efficient. These increments are further stopped when the final product has been developed.

1.3. V Model

The V Model follows a sequential path similar to the waterfall model. The previous phase has to be completed to initiate the next phase. Unlike the waterfall model, the testing part is give higher importance compared to other phases.

1.4. Spiral Model

The Spiral Model proposed by Boehm combines linear sequential and prototyping model. The entire model is divided into framework activities where there are different task regions. Depending on the type of project the number of steps involved vary. The task regions consist of customer communication, planning, risk analysis, engineering, construction and release and customer evaluation. The radial dimension of spiral is depicted by the cumulative cost involved in accomplishing work while the angular dimension is illustrated by the progress on the completion of each cycle.

Each cycle begins with analyzing the objectives of each cycle, alternative methods that can be used and existing constraints. These choices are then evaluated on the basis of the constraints and specifications in the objective while minimizing the risks associated. The model takes into account the risks involved unlike other models and is hence a superior model for large scale software development.

1.5. Evolutionary Prototyping Model

In Evolutionary Prototyping Model, the prototype is continually polished until the perfect product is arrived at. On the basis of the requirements known, each phase is developed in a vague manner. The various stages involved are designing, coding and testing. The model is more effective for the client as the client plays more role in the development by providing invaluable ideas the help determine the requirements for the system unlike other models. A repetitive procedure where the feedback from the user is received and incorporated by the developer is carried out until the prototype reaches completion. This model is preferred in cases where the developer lacks clarity on the requirements in advance.

2. MODEL CONSTRUCTION

Definition 2.1.

Let H denote a universal set. Then the function μ_C is defined as μ_C: H → [0, 1]. The function μ_C is called membership function and the set defined by it is called fuzzy set.

Definition 2.2.

Let H be an initial universe set and G be a set of parameters (real-valued variables). Let P(H) denote the power set of H and C ⊂ G. A pair (Ƒ, C) is called a soft set over H, where Ƒ is a mapping given by Ƒ: C → P(H).

Example 2.1.

Let H = {$Ш_1$, $Ш_2$, $Ш_3$, $Ш_4$, $Ш_5$} be the five selected software life cycle models in software engineering and G= {$®_1$, $®_2$, $®_3$, $®_4$} be the software life cycle parameters. Suppose that Ƒ ($®_1$) = {$Ш_1$, $Ш_3$, $Ш_5$}, Ƒ ($®_2$) = {$Ш_2$, $Ш_5$},

Ƒ ($®_3$) = {$Ш_2$, $Ш_4$, $Ш_5$}, Ƒ ($®_4$) = {$Ш_1$, $Ш_3$, $Ш_4$}

Table 1 Example of a Soft Set

U	$®_1$	$®_2$	$®_3$	$®_4$
$Ш_1$	1	0	0	1
$Ш_2$	0	1	1	0
$Ш_3$	1	0	0	1
$Ш_4$	0	0	1	1
$Ш_5$	1	1	1	0

Definition 2.3.

Let H be an initial universe set and G be a set of parameters (real-valued variables). Let P(H) denote the power set of all fuzzy sets of H and C ⊂ G. A pair (Ƒ, C) is called a Fuzzy Soft set over H, where Ƒ is a mapping given by Ƒ: C → P(H).

Table 2 Example of a Fuzzy Soft Set

U	$®_1$	$®_2$	$®_3$	$®_4$
$Ш_1$	0.8	0.2	0.3	0.7
$Ш_2$	0.5	0.5	1	0.7
$Ш_3$	0.6	0.4	0.9	0.3
$Ш_4$	0.7	0.45	0.5	0.9
$Ш_5$	0.8	0.35	0.64	0.65

In this table, w_{ij} corresponds to the software model $Ш_i$ and parameter $®_j$, where w_{ij} = membership value of $Ш_i$ in Ƒ ($®_j$)

Definition 2.3. Dominance Pack

It is a square table. Both are labelled by variables. Entries w_{ij} = the number of parameters for which the membership value of $Ш_i$ exceeds or equals the membership value of $Ш_j$.

Remark 2.1

$0 \leq w_{ij} \leq n$, where n is the number of parameters of the system.

Remark 2.2

Each main diagonal element of a dominance pack is always equal to the constant n, where n is the number of parameters of the system.

Definition 2.4: Model indicator

The row sum of $Ш_i$'s determine total cumulative impact on each model $Ш_i$'s

$E_{ri} = \sum_{j=1}^{n} wij$

Definition 2.5: Param factor

The Param factor is defined as

$Par_j = \sum_{i=1}^{n} wij$

Definition 2.5. The discrimination factor is defined as

$O_i = E_{ri} - Par_j$

3.1. Discrimination algorithm

1. Selection of models (Ш)
2. Identifying the parameters (®)
3. Compute the fuzzy soft set
4. Compute the Dominance Pack
5. Calculation of E_{ri} and Par_j
6. Estimation of discrimination factors
7. Construction of E_{ri} and Par_j optimization table
8. Identification of SLCM selection from the optimization table.

4. EXPERIMENT AND RESULT

The five important models are Spiral Model, V Model, Evolutionary Prototyping Model, Incremental Model and Waterfall Model which are denoted by $Ш^1$, $Ш^2$, $Ш^3$, $Ш^4$ and $Ш^5$. The three main criteria are people, process and technical. The twelve parameters of the above three main criteria are better manageability, user involvement and feedback, cost, complexity, criticality, flexibility, reusability and documentation, software quality, requirements management, testing and integration, focus on design and architecture and formal reviews. The proposed model involves five software engineering paradigms and 12 parameters. The parameters are denoted by denoted by {®m} for m = 1 to 12.

Table 4.1 Fuzzy soft set from collected data

U	®$_{1}$	®$_{2}$	®$_{3}$	®$_{4}$	®$_{5}$	®$_{6}$	®$_{7}$	®$_{8}$	®$_{9}$	®$_{10}$	®$_{11}$	®$_{12}$
ɯ^{1}	0.7	0.7	0.8	0.9	0.8	0.7	1.0	0.5	0.6	0.5	0.7	0.8
ɯ^{2}	0.6	0.9	0.8	1.0	0.7	0.9	0.6	0.8	0.7	0.8	0.9	0.9
ɯ^{3}	0.6	0.9	0.9	1.0	1.0	0.9	1.0	0.8	0.9	0.9	1.0	1.0
ɯ^{4}	0.8	0.6	0.7	0.6	0.7	0.5	0.7	0.5	0.5	0.6	0.5	0.4
ɯ^{5}	0.5	0.9	0.8	0.7	0.6	0.6	0.8	0.5	0.5	0.7	0.6	0.6

Table 4.2 Dominance Pack

U	ɯ^{1}	ɯ^{2}	ɯ^{3}	ɯ^{4}	ɯ^{5}
ɯ^{1}	12	4	2	10	10
ɯ^{2}	9	12	5	10	11
ɯ^{3}	11	12	12	11	12
ɯ^{4}	3	3	1	12	4
ɯ^{5}	4	3	1	10	12

Table 4.3 Optimization Table

U	Model Indicator	Param Factor	Discrimination Factor
ɯ^{1}	38	39	-1
ɯ^{2}	47	34	13
ɯ^{3}	58	21	37
ɯ^{4}	23	53	-30
ɯ^{5}	30	49	-19

The optimum decision is ɯ^{3} > ɯ^{2} > ɯ^{1} > ɯ^{5} > ɯ^{4}.

Evolutionary Prototyping > V Model> Spiral Model > Waterfall Model> Incremental Model.

4.1. Sensitivity analysis

The chances for sudden changes in parameters often create unexpected results. The MP (Model Param) ratio gives us some insights into the possible impacts such variations can produce. If MP ratio is greater than one, the cumulative impact of parameters affects the model. If MP ratio is less than unity the model will not be affected by such changes. If MP ratio is unity, the model is minimally affected by the changes in the parameters. We call that model a critical model. This is because any fluctuation in the estimation bank input critically affects the result. In such cases instead of constructing a fuzzy soft set for a given set of values, we take a sequence of values for each parameter which forms a real sequence. If it converges, the corresponding parameter shows consistency. Otherwise the parameter is significant in determining the nature of uncertainty of the prediction. If the convergent criteria for all input values are satisfied, this dominance pack gives us reliable results. Based on data collected from the areas of study, a dominance pack chart for the study of the behaviour of parameters has been developed. In all the fuzzy soft set tables constructed from the collected data, all the twelve parameters are inconsistent parameters.

5. CONCLUSION

The fuzzy soft set theory approach presented for SLCM selection furnishes very promising results and possibilities. The twelve parameters were analysed and membership grades were given to each parameter. The output shows that the Evolutionary Prototyping model has maximum Discrimination factor and hence it is the best model among the alternative models. The study is intended to enable researchers the world over to do more substantial studies in similar fields. More substantial improvement certainly should be pursued through further research to improve the decision making problems at greater lead time.

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