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A Modified Fuzzy Similarity Measure Decision Making Approach to SLCM Selection

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Abstract**—**Software engineering has been largely looked upon as a layered technology that integrates processes, people and technology for the software development. The choice of one particular model over a set of available models will depend on its efficacy and appropriateness. The ultimate goal of any form of software engineering is to build up the most efficient model and this build up will decide the future and successful completion of any project. The study intends to develop similarity measures between ordered intuitionistic fuzzy soft sets (OIFSSs). The proposed model is applied to five software life cycle models (SLCMs) so as to select the most appropriate one.

Keywords**—**Similarity measure, Software life cycle, Fuzzy decision making, Intuitionistic fuzzy soft sets

I. INTRODUCTION

Engineering influences every walk of life of humankind. It sometimes is unthinkable that someone can lead a normal life these days without the influence of the fruits of software engineering. One gets up in the morning listening to the alarm from one's smartphone. From day planner, travel, food, shop, communication, study, reading etc. one has umpteen numbers of mobile applications to rely on. The ultimate goal of any form of software engineering is to build up the most efficient model that makes human life most comfortable. An optimization problem comes with the outcomes with the best use of available resources. The Software Life Cycle Model (SLCM) aims at choosing the most appropriate model that makes use of the efforts more efficiently meeting the specific needs and challenges of the project in all phases of it. We propose a Modified Fuzzy Similarity Measure Decision-Making approach to five software life cycle models.

Once human beings grew into the consciousness of the processes through which events take place in nature, there have been attempts to have intelligent guesswork's to know the 'how' of foreseeing events in the future. The science of predicting future is not merely an act of absolute guesswork. It depends on the awareness and analysis of data that may be available in diverse forms. While some of the data are crisp, most of which are unintelligibly distributed. People always wish to take an informed decision. Decisions based on a historical evaluation and that are considered on the ramifications in the future are highly appreciated. Everyone is interested in a system that is supporting such informed decision-making.

Is it a realistic expectation? To a large extent, the two methods that are described below can achieve this. One method is comparatively simple as it involves only a direct extrapolation from the past events. It is quite a straightforward approach. However, the second method is hugely non-trivial and complicated. It is a model that uses a simulation of any given set of scenarios in terms of the input trajectories obtained from and founded on the prior observations. No obvious wild predictions which are relatively easier will come in the way of this method. However, to make the prediction accurate one needs a scientific basis which involves robust mathematical models. An efficient mathematical model deals with a number of variable inputs, manipulating which, one can have a reliable output.

This paper is organized as follows. Section I contains a general introduction to various approaches to software engineering. It also advocates the need for efficient software engineering models and their testing systems. Section II contains the related works and a short evaluation of five software life cycle models viz., the waterfall model, the incremental model, the V model, the spiral model and the evolutionary prototyping model. Section III contains the description of the model we propose. It also carries values obtained from simulation. Results and Discussion form the content of Section IV. Section V concludes research work with future directions. We pay respects to L. A. Zadeh (1921-2017) who proposed fuzzy mathematics [27] who passed away on September 6, 2017.

II. RELATED WORK

We encounter with decision-making in every moment of our daily life. The various choices available and the criteria to be maintained make it a rather difficult job. For example, someone with two cars, one with a petrol engine and the other with diesel, finds it confusing to choose one in lieu of the other, considering the fuel prices and the engine efficiency. This difficulty has given greater importance to the research regarding decision-making on smaller and larger issues and is now widely done. The classical Multi-Attribute Decision Making (MADM) methods cannot effectively handle inaccurate and inefficient information. Applications of fuzzy concepts in the areas of software engineering have become more common over the last decade. In this situation, Fuzzy Multi-Attribute Decision Making (FMADM) proves to be a better method to be used in areas like Applied Sciences, Computer Science, Artificial Intelligence, System control, Engineering, Technology and Management.

Traditional models in most cases are rigid and have tendencies to be inflexible. This would act as an impediment to the smooth functioning in areas where we do not have crisp and well-defined data. An appreciable share of data available in the real world is not crisp. The in-deterministic nature of these types of data renders traditional models incapable of efficiently dealing with them. Recently a vast number of researchers have used fuzzy logic (FL) in computer modelling simulation [1-27]. The computational speed in simulating and forecasting has become highly relevant in real-time operations. This act of simulation will have multifarious applications in the fields of environment, planning, farming, disaster monitoring capacity building, management, mitigation, etc. A user-friendly simulation model can be beneficial and relevant in these days of futuristic postulations.

Molodstov [14] introduced the powerful idea of the soft set which is capable of solving uncertainties. The fuzzy set (FS)can be applied in Economics, Psychology, Computer science, Engineering, Physics and in many areas of Mathematics. The crisp real values are converted into fuzzy values with the help of membership functions (MF).

Intuitionistic fuzzy sets (IFS) expounded by Atanassov [3] is a continuation of FS. In IFS, not only a membership grade is given, but also a non-membership grade, which is more or less independent is supplied. The IFS contains three parameters namely membership, non-membership and indeterminate grades. There is no universal scale to measure these parameters. A part of such estimation naturally remains indeterministic. This indeterministic part has not been considered in fuzzy set theory, rather it is assumed that membership grades of all the reference elements exist and have to be determined completely. However, the real-life situation is much different. Hence, for such an environment there is a need for the intuitionistic fuzzy sets which offers greater clarity. The attempt here is to make available the Ordered Intuitionistic Fuzzy Soft Set (OIFSS) model [20] in SLCM selection. The OIFSS model is developed, some results on them are set forth and an algorithm for SLCM selection in five software life cycle models is developed. In this paper, the material and method are introduced in section 2, result and discussion and conclusion are included in section 3and section4.

Software plays an important role in system development and product as it is the mediator between the user and the operating system. The production of the software is given direct emphasis while the software development process is taken into account. This includes activities like designing, coding and testing of the software programme. The development process model concerns with how according to the functioning of the model should be performed and the order in which they are done.

The development process becomes the core part of the software process as the quality assurance, meeting the necessities of the project etc. come along with this. Hence, the management procedure is designed completely based on the development process.

A production process can easily be understood imagining it as a flow chart. There are several steps involved which take a sequential pattern where the well-defined activity performed at each level gives an output which acts as the input for the next step. The activity thus defined focuses on meeting the satisfaction of the project goals. Most process models specify the functions to be performed at each step and the order in which they should act, but mostly fail to mention the time at which each of these steps should commence and terminate. This drawback results in some practical issues while implementing them.

A. *The Waterfall Model*

This was the first model to come up in the early 70's. Rather than being the first model, it is also one of the simplest process models where the phases take a linear structure. Depending on how the activities are ordered and depending on the flow of control between them, there are several kinds of waterfall models developed in the most basic model. The feasibility of the project is analyzed in the first step. Once the feasibility is successfully demonstrated, the second step analyses the tools and essentials for the project and the planning of the methodology of the project begins. On the successful completion of the requirement analysis, the designing process begins. After this, the coding process is done. Now, testing is done on the integrated code which rates the efficiency of the programme. On completion of all these processes successfully, the system is installed. Now, the system can be regularly functioned carrying out the required maintenance. This basic model progressing from analysis, design, coding, testing, implementation and finally support still remains the most basic and most efficient model. The waterfall model is applied only if the system requirements are well defined.

However, following a linear sequence for the ordering of activities has some consequences. Where the phases have begun and where they have ended, seem to have less clarity. A mechanism that can support the proper functioning of this aspect has to be implemented at the end of each level. This will also provide a clearer idea regarding the output at each phase. Obtaining the expected output is mandatory as it can be properly evaluated. Waterfall model suits best for the projects that have well-defined requirements and for the ones that are more precise about their problem domain and tool feasibility.

*B. **The Incremental Model***

The incremental model is created by increments in each phase of the project. It combines waterfall model and prototyping. In this model, a core product is put into the use for an evolutional purpose or used by the customer.

This model works slightly different from the waterfall model where the first increment to be given to the customer for use or to be reviewed is the core product itself without any development. After the reviewing by the customer, the product is analyzed and a plan is developed according to the newer requirements. In the course of evaluation or application by the customer, a plan is developed for an additional increment which could make the software more efficient. Additional features are thus added based on requirements and functionality. These accretions cease when the final product is arrived at.

*C. **The V Model***

This Model follows on the heels of the waterfall model and as such imitates a sequential path. It necessitates the completion of each step prior to the transition to the next step. In this model, the testing part is given more importance, unlike the waterfall model.

*D. **The Spiral Model***

This Model is the combination of prototyping and linear sequential model. This is a newer model proposed by Boehm. Here, the entire procedure is subdivided into several parts of activities where each of them is mentioned to be framework activity which involves different tasks commonly called as task regions. The number of steps involved varies depending on different projects. As the name suggests, the spiral model comes up with a radial dimension and angular dimension where the former represents the cumulative cost incurred in accomplishing work so far and the later represents the progress seen on the completion of each cycle. Each cycle begins with the analysis of the aspects such as finding out the objectives for each cycle, the alternative methods that can be implemented for better accomplishment of these objectives and the existing bounds and constraints. The next step is the evaluation procedure where all these choices are evaluated considering the constraints and specifications in the objective. The evaluation process focuses on the risk management ability of the project, as minimizing the risks maximises the probability for the project to meet the requirements specified in the objective. Involving activities such as benchmarking, simulation, and prototyping, we now develop strategies that can deteriorate the doubts and risks. The spiral model, as it takes into consideration the potential risks involved, is rather considered as a better efficient model for large-scale software development thereby reduces the possibility of crashes.

*E. **The Evolutionary Prototyping Model***

In this model, we have a prototype which is continually refined until the perfect product is arrived at. Here a better understanding of the system is made available for the client of the project. This is more of a throwaway prototype other than freezing the requirements before designing and coding. Each phase is developed in a vague manner based on the known requirements. Design, coding, testing, etc. are the different stages.

In dealing with large and complicated systems, *prototyping* is an attractive and effective method. The user is enabled to provide the feedback and make suggestions for change. The developer incorporates these into the prototype. This becomes a continuous process till the prototype reaches completion. This model is more useful in cases where the developer is not fully aware of the requirements in advance.

III. MATERIAL AND METHOD

Model is a schematic representation of reality. The objective of a model is to characterize qualitatively or compute quantitatively the behaviour of systems. Every real-world problem can be converted into a mathematical model. It contains equations and algorithms for their respective environments. The different step by step procedures of a mathematical model are: identifying the problem, estimating the parameters, identifying the relationship between the parameters, constructing the model, experimentation and analysis and validation of the model.

***Definition 1* [27]:** Let Y be a universal set. The function μ_B is defined as, μ_B: Y$\rightarrow$ [0, 1] ....(1)

The function μ_B is called the membership function (MF) and the set defined by it is called the fuzzy set.

***Definition 2* [14]:** Let P(V) be the power set of the universe set V and B⊂G, the variables. Let (Ғ, B) be a soft set over V, where Ғ: B→ P(V).

***Example 1*:**

Let V = {Ж$_1$, Ж$_2$, Ж$_3$, Ж$_4$, Ж$_5$} be the decisions. Let G= {**Ҧ**$_1$, **Ҧ**$_2$, **Ҧ**$_3$, **Ҧ**$_4$} be the parameters. Suppose that Ғ(**Ҧ**$_1$)={Ж$_1$, Ж$_2$, Ж4**}**, Ғ(**Ҧ**$_2$)= **{**Ж$_3$, Ж$_5$**}**, Ғ(**Ҧ**$_3$)={Ж$_1$, Ж$_2$, Ж$_3$} and Ғ(**Ҧ**$_4$)= {Ж$_2$, Ж$_3$,Ж$_5$}.

Table 1. Example of a soft set

V	**Ҧ1**	**Ҧ2**	**Ҧ3**	**Ҧ4**
Ж$_1$	1	0	1	0
Ж$_2$	1	0	1	1
Ж$_3$	0	1	1	1
Ж$_4$	1	0	0	0
Ж$_5$	0	1	0	1

***Definition 3* [15]:** Let P (V) the set of all fuzzy sets of the universe set V and B ⊂ G, the variables. **(**Ғ, B) is a fuzzy soft set (FSS) over V, where Ғ: B → P(V).

Table 2. Example of FSS

V	**Ҧ1**	**Ҧ2**	**Ҧ3**	**Ҧ4**
Ж$_1$	0.7	0.4	0.7	0.8
Ж$_2$	05	0.6	1	0.6
Ж$_3$	0.3	0.4	0.9	0.3
Ж$_4$	0.9	0.45	0.5	0.55
Ж$_5$	0.8	0.3	0.4	0.65

***Definition 4*[3]:** An Intuitionistic Fuzzy Set (IFS) is defined as

C = $\left\{\langle y, \left(\left(\mu_c(y)\right), v_c(y)\right)\rangle \,|y \in G\right\}$ ……………….........(2)

where μ_C: G→[0,1] and ν_C: G→[0,1]. The functions μ_C and ν_C are called membership value (MV) and non-membership value (NV), respectively. It is to be noted that $0 \le \mu_C(y) + \nu_C(y) \le 1$, $\pi_A(y) = 1 - \mu_C(y) - \nu_C(y)$, $0 \le \pi_C(y) \le 1$. This is called the in-deterministic part for y.

***Definition 5* [16]:** Let P(V) be the set of all IFSs of the universe set V. Let B⊂G, the variables. (Ғ, B) is an IFSSs over V, where Ғ: B→P(V).

***Definition 6*:** If $\mu_A(x)$ and $\nu_A(x)$ are the MV and NV of the element x to the set A, then

$$\nu_A(x) = \begin{cases} \dfrac{0.5*\alpha\left[1-\mu_A(x)\right]}{\max\left[\mu_A(x), 1-\mu_A(x)\right]} & if \quad \mu_A(x) \ge 0.5 \\ \dfrac{0.5*\alpha\left[1-\mu_A(x)\right]^2}{\min\left[\mu_A(x), 1-\mu_A(x)\right]} & if \quad 0 < \mu_A(x) < 0.5 \\ 1 & if \quad \mu_A(x) = 0 \end{cases}$$

where α is a dominating fuzzy index and $0 \le \alpha \le 1$.

***Definition 7*:** An Ordered Intuitionistic Fuzzy Set (OIFS) in G is defined as

$$B_{e,f} = \left\{\langle y, \left(\mu_B(y)\right)^e, \left(\nu_B(y)\right)^f\rangle \,\middle|\, y \in G\right\} \cdots\cdots (3)$$

$$\mu_B^e: G \to [0,1] \text{ and } \nu_B^f: G \to [0,1]$$

where $e, f \in N$ and are called weighted indices of the set B.

$$0 \le \left(\mu_B(y)\right)^e + \left(\nu_B(y)\right)^f \le 1,$$

$\pi_{B_{e,f}}(y) = 1 - \left(\mu_B(y)\right)^e - \left(\nu_B(y)\right)^f$ is called the ordered in-deterministic part for *x*. Clearly, $0 \le \pi_{Be,f}(y) \le 1$.
If e = *f=1*, $B_{1,1}$ is called IFS.

***Definition 8*:** Let □$_{e,f}$(V) be the set of all OIFSS of the universal set V. Let B⊂G, the variables. (Ғ, B) is an OIFSS over V, where Ғ: B→□$_{e,f}$(V).

***Definition 9*:**

The half OIFSS C = $\left\{\langle y, \left(\frac{\left(\mu_C(y)\right)^e}{2}, \frac{\nu_C(y)}{2}\right)^f\rangle \,\middle|\, y \in G\right\}$ where $\frac{\left(\mu_B(y)\right)^e}{2}$ and $\frac{\left(\nu_B(y)\right)^f}{2}$ are denoted as the MV and NV, respectively and $e, f \in N$.

***Definition 10*:**

If $C_{e,f}$ and $D_{g,h}$ are any two OIFSSs of the set G, then

$$\overline{C_{e,f}} = \left\{\langle y, \left(\nu_C(y)\right)^f, \left(\mu_C(y)\right)^e\rangle \,\middle|\, y \in G\right\}$$

$$C_{e,f} \cap D_{g,h} = \{\langle y, \min[\left(\mu_C(y)\right)^e, \left(\mu_D(y)\right)^g], \max\left[\left(\nu_C(y)\right)^f, \left(\nu_D(y)\right)^h\right]\rangle \,|y \in G\}$$

$$C_{e,f} \cup D_{g,h} = \{\langle y, \max[\left(\mu_C(y)\right)^e, \left(\mu_D(y)\right)^g], \min\left[\left(\nu_C(y)\right)^f, \left(\nu_D(y)\right)^h\right]\rangle \,|y \in G\}$$

$$C_{e,f} + D_{g,h} = \{\langle y, (\mu_C(y))^e + (\mu_D(y))^g - (\mu_C(y))^e \cdot (\mu_D(y))^g, (\nu_C(y))^f . (\nu_D(y))^h | y \in G\}$$

$$C_{e,f} . D_{g,f} = \{\langle y, (\mu_C(y))^e \cdot (\mu_D(y))^g, (\nu_C(y))^f + (\nu_D(y))^h - (\nu_C(y))^f . (\nu_D(y))^h \} | y \in G\}$$

***Definition 11*:**

Let $(Super)_{i,j}$ be the Ordered Super Intuitionistic Fuzzy Soft Set (OSIFSS) of Y. Then $(Super)_{i,j}$ is called OSIFSS of Y if $(\mu_{Super}(y))^i = 1, (\nu_{Super}(y))^j = 0 \text{ and } \pi_{Null_{i,j}}(y) = 0, \forall y \in Y.$

Definition 12 :

Let $(Null)_{i,j}$ be the ordered null intuitionistic fuzzy soft set (ONIFSS) of Y. Then $(Null)_{i,j}$ is called ONIFSS of Y if $(\mu_{Null}(y))^i = 0,\ (\nu_{Null}(y))^j = 1$ and $\pi_{Null_{i,j}}(y) = 0,$ $for\ all\ y \in Y$, where Y be the set of all OIFSSs.

Similarity measures between OIFSSs, can be applied in various fields of computer modeling research namely software lifecycle selection, cost estimation of the project, time scheduling, project team selection, software quality checking, prioritizing project activities, software error measuring, product selection, developments strategy selection, data mining etc.

Let $€(Y)$ be the set of all OIFSSs of X. Let $J_{e,f}, K_{g,h} \in €(X)$, where e, f, g, h $\in N$. Let $Ƭ_{dk}$ be the different similarity measures such that $Ƭ_{dk} : (€(X))^2 \to [0,1]$ for $k = 1, 2$ and $w = e + f + g + h$.

***Definition* 13**:

$$Ƭ_{d_1}^{e,f,g,h}(J_{e,f},\ K_{g,h}) = 1 - \frac{1}{2m} ₣ \quad \text{......................} \quad (5)$$

where,

$$₣ = \sum_{j=1}^{n} \left[|ꞡ^{(e,g)}(j)|^{\frac{(e+g)}{2}} + |ʒ^{(f,h)}(j)|^{\frac{(f+h)}{2}} + |ɘ^{(e,f,g,h)}(j)|^{\frac{w}{4}} \right]$$

$ꞡ^{(e,g)}(j) = (\mu_J(x_j))^e - (\mu_K(x_j))^g,$

$ʒ^{(f,h)}(j) = (\nu_J(x_j))^f - (\nu_K(x_j))^h,$

$ɘ^{(e,f,g,h)}(j) = \pi_{J_{e,f}}(x_j) - \pi_{K_{g,h}}(x_j)$

and m is the number of parameters. If $g = e$ and $h = f$, then

$$Ƭ_{d_1}^{e,f}(J_{e,f},\ K_{e,f}) = 1 - \frac{1}{2m} ₣1 \text{..........................} (6)$$

where,

$$₣1 = \sum_{j=1}^{n} \left[|ꞡ^{(e,e)}(j)|^e + |ʒ^{(f,f)}(j)|^f + |ɘ^{(e,f)}(j)|^{\frac{e+f}{2}} \right]$$

$ꞡ^{(e,e)}(j) = (\mu_J(x_j))^e - (\mu_K(x_j))^e,$

$ʒ^{(f,f)}(j) = (\nu_J(x_j))^f - (\nu_K(x_j))^f,$

$ɘ^{(e,f)}(j) = \pi_{J_{e,f}}(x_j) - \pi_{K_{e,f}}(x_j).$

***Definition 14*:**

$$Ƭ_{d_2}^{e,f,g,h}(J_{e,f},\ K_{g,h}) = 1 - \sqrt{\frac{Ꝁ_1}{Ꝁ_2}} \quad \text{........................} (7)$$

where,

$$Ꝁ_1 = \sum_{j=1}^{n} \left[|ꞡ^{(e,g)}(j)|^{\frac{(e+g)}{2}} + |ʒ^{(f,h)}(j)|^{\frac{(f+h)}{2}} + |ɘ^{(e,f,g,h)}(j)|^{\frac{w}{4}} \right]$$

$$Ꝁ_2 = \sum_{j=1}^{n} \left[|ɤ^{(e,g)}(j)|^{\frac{(e+g)}{2}} + |ɮ^{(f,h)}(j)|^{\frac{(f+h)}{2}} + |ɰ^{(e,f,g,h)}(j)|^{\frac{w}{4}} \right]$$

$ꞡ^{(e,g)}(j) = (\mu_J(x_j))^e - (\mu_K(x_j))^g,$

$ʒ^{(f,h)}(j) = (\nu_J(x_j))^f - (\nu_K(x_j))^h,$

$ɘ^{(e,f,g,h)}(j) = \pi_{J_{e,f}}(x_j) - \pi_{K_{g,h}}(x_j),$

$ɤ^{(e,g)}(j) = (\mu_J(x_j))^e + (\mu_K(x_j))^g,$

$ɮ^{(f,h)}(j) = (\nu_J(x_j))^f + (\nu_K(x_j))^h,$

$ɰ^{(e,f,g,h)}(j) = \pi_{J_{e,f}}(x_j) + \pi_{K_{g,h}}(x_j)$

If $g = e$ and $h = f$, then

$$Ƭ_{d_2}^{e,f}(J_{e,f},\ K_{e,f}) = 1 - \sqrt{\frac{Ꝁ_1}{Ꝁ_2}} \quad \text{........................} (7)$$

where,

$$Ꝁ_1 = \sum_{j=1}^{n} \left[|ꞡ^{(e,e)}(j)|^e + |ʒ^{(f,f)}(j)|^f + |ɘ^{(e,f)}(j)|^{\frac{e+f}{2}} \right]$$

$$Ꝁ_2 = \sum_{j=1}^{n} \left[|ɤ^{(e,e)}(j)|^e + |ɮ^{(f,f)}(j)|^f + |ɰ^{(e,f)}(j)|^{\frac{e+f}{2}} \right]$$

$ꞡ^{(e,e)}(j) = (\mu_J(x_j))^e - (\mu_K(x_j))^e,$

$ʒ^{(f,f)}(j) = (\nu_J(x_j))^f - (\nu_K(x_j))^f,$

$ɘ^{(e,f)}(j) = \pi_{J_{e,f}}(x_j) - \pi_{K_{e,f}}(x_j),$

$ɤ^{(e,e)}(j) = (\mu_J(x_j))^e + (\mu_K(x_j))^e,$

$ȝ^{(f,f)}(j) = \left(\nu_J(x_j)\right)^f + \left(\nu_K(x_j)\right)^f,$
$щ^{(e,f)}(j) = \pi_{J_{e,f}}(x_j) + \pi_{e,f}(x_j).$

Remark 1: $0 \leq Ʈ_{d_k}^{e,f,g,h}(J_{e,f}, K_{g,h}) \leq 1.$

Remark 2: $Ʈ_{d_k}^{e,f,g,h}(J_{e,f}, K_{g,h}) = Ʈ_{d_k}^{g,h,e,f}(K_{g,h}, J_{e,f}).$

Remark 3: $Ʈ_{d_k}^{e,f,g,h}(J_{e,f}, K_{g,h}) = 1$ if and only if $J_{e,f} = K_{g,h}$. i.e., $\left(\mu_J(x_j)\right)^e = \left(\mu_K(x_j)\right)^g$ and $\left(\nu_J(x_j)\right)^f = \left(\nu_K(x_j)\right)^h$ for any $x_j \in G$.

Remark 4: $Ʈ_{d_k}^{e,f,g,h}(J_{e,f}, K_{g,h}) = 0$ and $Ʈ_{d_k}^{e,f,t,u}(J_{e,f}, R_{t,u}) = 0$, then- $Ʈ_{d_k}^{g,h,t,u}(K_{g,h}, R_{t,u}) = 0$.

***Definition15*:**
Let $J_{e,f}$ and $K_{g,h}$ are any two OIFSSs of G. Then $J_{e,f}$ is dominate $K_{g,h}$ if

$$Ʈ_{d_k}^{i,j,e,f}\left((Super)_{i,j}, \quad J_{e,f}\right) \geq Ʈ_{d_k}^{i,j,g,h}\left((Super)_{i,j}, K_{g,h}\right)$$

A. *The Similarity Measure Algorithm*

This algorithm computes the optimum output of the fuzzy modelling. The three important processes of the fuzzy modelling are fuzzification, fuzzy computation and de-fuzzification.

1. Identify relevant parameters($\mathbb{R}_m$).
2. Identify appropriate Models ($Ж^n$)
3. Construct OIFSS $Ж_{e,f}^n$
4. Calculate $\pi_{Ж_{e,f}^n}(\mathbb{R}_m)$
5. Calculate $Ʈ_{d_k}^{i,j,e,f}\left((Super)_{i,j}, Ж_{e,f}^n\right)$
6. Compute $Ж^n$ using the relation

$$Ʈ_{d_k}^{i,j,e,f}\left((Super)_{i,j}, Ж_{e,f}^n\right) = \max_{i} Ʈ_{d_k}^{i,j,e,f}\left((Super)_{i,j}, Ж_{e,f}^n\right)$$

7. If $Ж_{e,f}^n$ is not unique, choose that one corresponding to which $\sum_m \sum_{r=1}^n \pi_{\pi_{Ж_{e,f}^r}(\mathbb{R}_m)}$ is maximum
8. The optimum is $Ж^n$.

IV. Results and Discussion

Here, we present an application for the selection of an SLCM based on the proposed model, shown in Table III and IV.Having taken advice from the well-informed in the field and keeping in mind the specific needs of the project five SLCM variants are proposed. These models are Spiral Model, V Model, Evolutionary Prototyping Model, Incremental Model and Waterfall Model which are denoted by $Ж^1$, $Ж^2$, $Ж^3$, $Ж^4$and $Ж^5$, respectively. The three main criteria are people, process, and technology. The twelve parameters of the above three main criteria are better manageability, user involvement and feedback, complexity, flexibility, criticality, cost, reusability and documentation, requirements management, focus on design and architecture, software quality, testing and integration, and formal reviews. The proposed model involves five software engineering paradigms and 12 parameters. The parameters are denoted by $\{\mathbb{R}_m\}$ from = 1 to 12.

The OIFSSs are
$\{\mathbb{R}_1\}$= {$Ж^1$/((0.7)^2, (0.107)^1), $Ж^2$/ ((0.6)^1, (0.2)^2), $Ж^3$/ ((0.6)^2, (0.2)^2), $Ж^4$/((0.9)^2,(.056)^1), $Ж^5$/ ((0.5)^2, (.25)^2)},
$\{\mathbb{R}_2\}$= {$Ж^1$/ (0.7^1, 0.199^2), $Ж^2$/ (0.8^1, 0.1^3), $Ж^3$/ (0.9^3, 0.056^2), $Ж^4$/ (0.6^1, 0.33^2), $Ж^5$/ (0.9^2, 0.056^1)},
$\{\mathbb{R}_3\}$= {$Ж^1$/ (0.8^1, 0.1^1), $Ж^2$/ (0.8^1, 0.1^3),$Ж^3$/ (1^1, 0), $Ж^4$/ (0.7^2, 0.199^1), $Ж^5$/ (0.8^2, 0.1^1)},
$\{\mathbb{R}_4\}$= {$Ж^1$/ (0.9^2, 0.056^1), $Ж^2$/ (0.9^1, 0), $Ж^3$/ (1^1, 0), $Ж^4$/ (0.8^1, 0.1^2), $Ж^5$/ (0.9^2, 0.056^1)},
$\{\mathbb{R}_5\}$={$Ж^1$/ (1^1, 0), $Ж^2$/ (0.5^2, 0.1^1), $Ж^3$/ (1^1, 0), $Ж^4$/ (0.5^2, 0.3^1),$Ж^5$/ (0.5^2, 0.3^1)},
$\{\mathbb{R}_6\}$= {$Ж^1$/ (0.5^2, 0.4^1), $Ж^2$/ (1^1, 0), $Ж^3$/ (1^1, 0), $Ж^4$/ (0.5^2, 0.4^2),$Ж^5$/ (0.5^2, 0.4^1)},
$\{\mathbb{R}_7\}$= {$Ж^1$/ (0.5^2, 0.4^1), $Ж^2$/ (0.6^1, 0.2^2),$Ж^3$/ (1^1, 0), $Ж^4$/ (0.4^2, 0.427^2), $Ж^5$/ (0.9^2, 0.056^1)},
$\{\mathbb{R}_8\}$= {$Ж^1$/ (0.8^1, 0.1^1), $Ж^2$/ (0.8^1, 0.1^3), $Ж^3$/ (1^1, 0), $Ж^4$/ (0.7^2, 0.199^1), $Ж^5$/ (0.8^2, 0.1^1)},
$\{\mathbb{R}_9\}$= {$Ж^1$/ (1^1, 0), $Ж^2$/ (0.5^2, 0.1^1), $Ж^3$/ (1^1, 0), $Ж^4$/ (0.5^2, 0.3^1), $Ж^5$/ (0.5^2, 0.3^1)},
$\{\mathbb{R}_{10}\}$= {$Ж^1$/ (0.5^2, 0.4^1), $Ж^2$/ (0.6^1, 0.2^2), $Ж^3$/ (1^1, 0), $Ж^4$/ (0.4^2, 0.427^2), $Ж^5$/ (0.9^2, 0.056^1)},
$\{\mathbb{R}_{11}\}$= {$Ж^1$/ (0.7^2, 0.107^1), $Ж^2$/ (0.6^1, 0.2^2), $Ж^3$/ (0.6^2, 0.2^2), $Ж^4$/ (0.9^2, 0.056^1), $Ж^5$/ (0.5^2,0.25^2)},
$\{\mathbb{R}_{12}\}$= {$Ж^1$/ (0.5^2, 0.4^1), $Ж^2$/ (1^1, 0), $Ж^3$/ (1^1, 0), $Ж^4$/ (0.5^2, 0.4^2), $Ж^5$/ (0.5^2, 0.4^1)}.

The output of the fuzzy computing model is

$Ʈ_{d_1}^{i,j,e,f}\left((Super)_{i,j}, Ж_{e,f}^1\right)$= 0.6755,
$Ʈ_{d_1}^{i,j,e,f}\left((Super)_{i,j}, Ж_{e,f}^2\right)$= 0.7736,
$Ʈ_{d_1}^{i,j,e,f}\left((Super)_{i,j}, Ж_{e,f}^3\right)$= 0.9173,
$Ʈ_{d_1}^{i,j,e,f}\left((Super)_{i,j}, Ж_{e,f}^4\right)$= 0.5817,
$Ʈ_{d_1}^{i,j,e,f}\left((Super)_{i,j}, Ж_{e,f}^5\right)$= 0.6345,
$Ʈ_{2}^{i,j,e,f}\left((Super)_{i,j}, Ж_{e,f}^1\right)$= 0.4469,
$Ʈ_{d_2}^{i,j,e,f}\left((Super)_{i,j}, Ж_{e,f}^2\right)$ = 0.5179,
$Ʈ_{d_2}^{i,j,e,f}\left((Super)_{i,j}, Ж_{e,f}^3\right)$= 0.7241,
$Ʈ_{d_2}^{i,j,e,f}\left((Super)_{i,j}, Ж_{e,f}^4\right)$= 0.3632,

$Ꞇ_{d_2}^{i,j,e,f}\left((Super)_{i,j},\ Ж_{e,f}^{5}\right)=\ 0.4396.$

The optimum decision is $Ж^3$>$Ж^2$>$Ж^1$>$Ж^5$>$Ж^4$.

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

Table 3. Ordered Intuitionistic Fuzzy Set

V	$Ж_{e,f}^{1}$	$Ж_{e,f}^{2}$	$Ж_{e,f}^{3}$	$Ж_{e,f}^{4}$	$Ж_{e,f}^{5}$
$\mathbb{R}_1$	(.49,.107)	(.6,.04)	(.36,0.04)	(.81,.056)	(0.25,0.25)
$\mathbb{R}_2$	(.7,.0396)	(.8,.001)	(.72,.003)	(.6,.1089)	(0.81,.056)
$\mathbb{R}_3$	(0.8,0.1)	(.8,.001)	(1.0,0.0)	(0.4,0.199)	(0.64, 0.1)
$\mathbb{R}_4$	(.81,.056)	(0.9,0)	(1.0,0.0)	(0.8,0.01)	(0.81,.056)
$\mathbb{R}_5$	(1.0,0.0)	(0.25,0.1	(1.0,0.0)	(0.25,0.3)	(0.25, 0.3)
$\mathbb{R}_6$	(0.25,0.4)	(1.0,0.0)	(1.0,0.0)	(0.25,0.16)	(0.25,0.4)
$\mathbb{R}_7$	(0.25, .4)	(0.6,0.04)	(1.0,0.0)	(0.25,0.3)	(0.25,0.3)
$\mathbb{R}_8$	(0.8,0.1)	(0.8,.001)	(1.0,0.0)	(0.49,.199)	(0.64,0.1)
$\mathbb{R}_9$	(1.0,0.0)	(0.25,0.1)	(0.9,0.0)	(0.25,0.3)	(0.25,0.3)
$\mathbb{R}_{10}$	(0.25, .4)	(0.6,0.04)	(1.0,0.0)	(0.16,.182)	(0.81,.056)
$\mathbb{R}_{11}$	(.49,.107)	(0.6,0.04)	(.35, .04)	(0.81,.056)	(0.25,0.25)
$\mathbb{R}_{12}$	(0.25,0.4)	(1.0,0.0)	(0.9,0.0)	(0.25,0.16)	(0.25,0.4)

Table 4. Representation of $\boldsymbol{\pi}_{Ж_{e,f}^{n}}(\mathbb{R}_{\boldsymbol{m}})$

U	$Ж_{e,f}^{1}$	$Ж_{e,f}^{2}$	$Ж_{e,f}^{3}$	$Ж_{e,f}^{4}$	$Ж_{e,f}^{5}$
$\mathbb{R}_1$	0.403	0.36	0.60	0.134	0.50
$\mathbb{R}_2$	0.2604	0.199	0.268	0.2911	0.134
$\mathbb{R}_3$	0.10	0.199	0.0	0.311	0.26
$\mathbb{R}_4$	0.134	0.1	0.0	0.19	0.134
$\mathbb{R}_5$	0.0	0.65	0.0	0.45	0.45
$\mathbb{R}_6$	0.35	0.0	0.0	0.59	0.35
$\mathbb{R}_7$	0.35	0.36	0.0	0.657	0.134
$\mathbb{R}_8$	0.10	0.199	0.0	0.311	0.26
$\mathbb{R}_9$	0.0	0.65	0.1	0.45	0.45
$\mathbb{R}_{10}$	0.35	0.36	0.0	0.657	0.134
$\mathbb{R}_{11}$	0.403	0.365	0.6	0.134	0.50
$\mathbb{R}_{12}$	0.35	0.0	0.0	0.59	0.35

A. Analysis

In this work, we developed an OIFSS model to select an appropriate SLCM. The similarity measures are applied for five selected system life cycle models in Software Engineering. The membership, non-membership and indeterministic grades are assigned to each parameter. Pertinent weight is supplied so as to enhance the relative strength of the model parameters. Weight has been supplied to provide maximum efficacy to diverse parameters. The increase in the number of parameters (weight of membership and non-membership) makes the model structurally more stable.

In providing the system with enhanced capabilities so as to make it applicable to a universalized scheme, the OIFSS model takes into consideration a computational model which computes elements within the set as well as a universal super intuitionistic fuzzy set. This offers a comprehensive all-inclusive perfect model to which other less comprehensive models can be compared and analyzed so as to provide greater reliability and applicability.

The cumulated measure $Ꞇ_{d_k}^{i,j,e,f}\left((Super)_{i,j},Ж_{e,f}^{n}\right)$ is analyzed on the basis of its dependability. Identical outputs are generated by the application of either of the proposed similarity measures. The choice of parameters play a critical role in the SLCM selection.

The analysis reveals that the weighted indices of **e** and **f** of the fuzzy computing model $Ꞇ_{d_k}^{i,j,e,f}\left((Super)_{i,j},Ж_{e,f}^{n}\right)$ are always unity. They always remain consistent. The indices **e** and **f** vary according to differences in situations. $Ꞇ_{d_k}^{i,j,e,f}\left((Super)_{i,j},Ж_{e,f}^{n}\right)$ leads to the finding of **e.** Its membership grade is inversely related. Similarly, **f** also demonstrates identical inverse relationship.

V. CONCLUSION and Future Scope

The optimum solution is $Ж^3$**.** It reveals that the Evolutionary Prototyping model has the largest computational value $Ꞇ_{d_k}^{i,j,e,f}\left((Super)_{i,j},Ж_{e,f}^{n}\right)$and hence it is the most suitable one. The study is intended to enable researchers the world over to do more substantial studies in similar fields. The future unfolds up for greater possibilities taking in to consideration the huge potential the model has and the diverse avenues that open up in the field of further researches in these areas.

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