Fuzzification of Empirical Software Estimation model and its Comparison

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Abstract

Accurate software estimation such as effort and cost estimation is a typical process and is a major issues in software project development. Estimation of software project effort and cost are very essential and necessary to improve software management decision.software estimation consist many estimation like cost estimation, quality estimation, effort estimation and risk analysis.This paper is confined on effort estimation based on fuzzy empirical model. Many empirical model were used in early days for effort estimation. This Paper Shows a very simple work using fuzzy logic for software effort estimation..

Three empirical model walston-felix model, bailey-basili mode and bohem simple model are considered in this piece of research for fuzzification. Input variable KLOC and output Variable effort of all the above model are fuzzified and result is compared. Result obtain after fuzzification is satisfauly

Keywords: Software estimation , Walston – Felix Model , Bailey – Basili Model , Boehm Simple Model , Fuzzy Logic,KLOC.

1. Introduction

Accurate software estimation such as cost estimation, quality estimation and risk analysis is a major issue in software project management. As software development has become an essential investment for many organizations, software estimation is gaining an ever-increasing importance in effective software project management. In practice, software estimation includes cost estimation, quality estimation, risk analysis, etc. Accurate software estimation can provide powerful assistance for software management decisions. The principal challenges are:-

1) The relationships between software output metrics and contributing factors exhibit strong complex nonlinear characteristics;
2) measurements of software metrics are often imprecise and uncertain;
3) difficulty in utilizing both expert knowledge and numerical project data in one model.

Software Engineering Estimation (SEE) is a process of predicting the efforts and cost in terms of money, schedule and staff for any software system, Software cost estimation is an old arts come with the beginning of computer industry in 1940s and it has been developed many times until formulating function points by Albrecht in 1979.

Nowadays software cost of estimation become a complicated branched science hence many functional sizing techniques, sizing metrics, cost and effort models appeared which probably not exist in this volume in the rest of sciences, this paper shows the common techniques used in SEE in general in addition it highlights the most important trends in this field also it show the urgent topics to be investigated and the challenges in SEE process.

SEE is a process used in software development industry to estimate or predict the resource, efforts, cost of any development process, furthermore to the management controlling and monitoring process over the software development process, before inventing the techniques of estimation in the beginning of 1970 the software estimation process was mainly depend on a rules of thumb and some simple algorithms to estimate the size, efforts and cost after that the idea of function points was

introduced by Albrecht which till now gain a high reliability in the estimation process, since that time many studies carried on function points to calibrate its weights, modify its parameters and its adjustment factors to reflect the current improvement in technology and software development industry.

The software cost estimation process is consider a fertilize field to investigate it, since it has a main role in decision making at all levels managers, developers, users "customers", for this extra importance reasons, software estimation process should have extra efforts from the researcher and it need extra cooperation from the industrial software development company to provide the researchers by the necessary data to propose and develop a suitable proper models for the estimation process at all, here is some of the hot topics which need more focus investigation from the researchers.

2. Fuzzy Logic

Fuzzy Logic is a problem-solving control system methodology that lends itself to implementation in systems ranging from simple, small, embedded micro-controllers to large, networked, multi-channel PC or workstation-based data acquisition and control systems. It can be implemented in hardware, software, or a combination of both. FL provides a simple way to arrive at a definite conclusion based upon vague, ambiguous, imprecise, noisy, or missing input information. FL's approach to control problems mimics how a person would make decisions, only much faster.

The Main Summary of the Fuzzy Logic was conceived 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.

3. Emprical Software Estmation Model

There are various empirical models which is KLOC based There are :-

Walston – Felix Model :-

$$E=5.2x(KLOC)^{0.91} \text{ ----------(i)}$$

Bailey – Basili Model

$$E=5.5 \times 0.73 \times (KLOC)^{1.16} \text{ ----------(ii)}$$

Boehm Simple Model

$$E=3.2 \times (KLOC)^{1.05} \text{ ----------(iii)}$$

A Quick examination of these models is indicates that each will yield a different result for the same values of KLOC.

4. Fuzzification and Rule base Devlepment

Three Model Walston – Felix Model , Bailey – basili Model , Boehm Simple Model are fuzzified. Input and output in all the above model are KLOC and effort respectively.

(I) Fuzzification of Walston – Felix Model

Membership Function of KLOC and Effort for this model is show in Fig 1 and 2 respectively. Four Lingstic Variable Low , Medium , high , V. High are taken in both .Effort is directly proportional to KLOC hence simple rule base with Four rules as hes been developed. The universe of discourse for input and output is taken randomly.

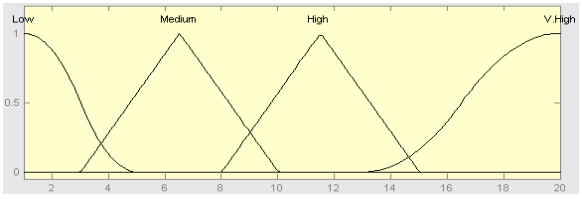

Fig. 1 : Fuzzification of KLOC

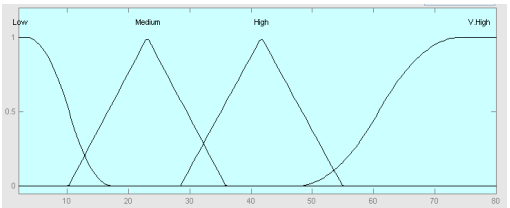

Fig. 2 : Fuzzification of Effort

I

1. If (KLoc is Low) then (Effort is Low)
2. If (KLoc is Low) then (Effort is Low)
3. If (KLoc is High) then (Effort is High)
4. If (KLoc is V.High) then (Effort is V.High)

Fig 3 And Fig 4 Shows Rule – Firing Process and surface viewer respectively according to Fig 4 it is clear that KLOC is directly proportional to effort. Curve (Fig 4) is not smooth due to less number .of rules we may get smooth curve by increasing number of linguistic variable and hence by increasing number of rules.

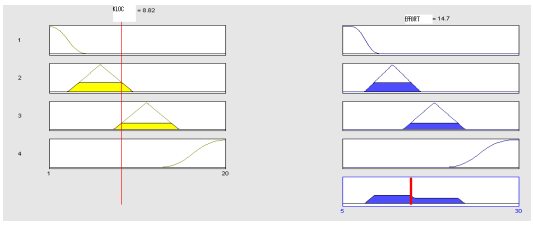

Fig 3 : Rule Firing Process

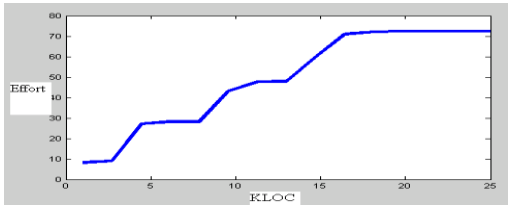

Fig 4 : Surface Viewer

(II) Fuzzification of Baily – Basili Model

Similarly Baily – Basili Model is fuzzyfied for it's input and output variable. Universe of discourse us decided by obtaining effort for correspondly KLOC with the help of C program and then Four Lingstic Variables Low , Medium , High and Very High is original for both KLOC and effort as shown in Fig 5 and Fig 6.

After that rule base is developed four rules for four linguistic Variable are developed

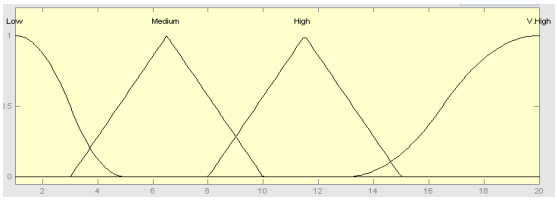

Fig. 5 : Fuzzification of KLOC

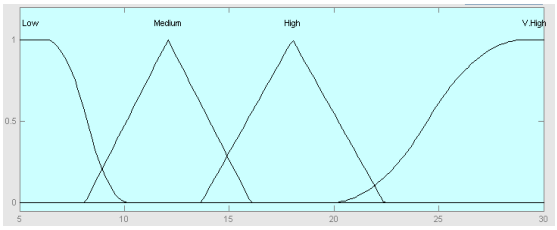

Fig. 6 : Fuzzification of Effort

1. If (KLoc is Low) then (Effort is Low)
2. If (KLoc is Low) then (Effort is Low)
3. If (KLoc is High) then (Effort is High)
4. If (KLoc is V.High) then (Effort is V.High)

Rule Firing process for KLOC = 8.82 is show which is showing effort = 14.7 after implication and defuzzification as show in Fig 7. this data (effort = 14.7) is very near to the actual effort obtain directly through the formula for KLOC = 8.82.

Fig. 8 Clearly shows the trend and relationship in between KLOC and effort.

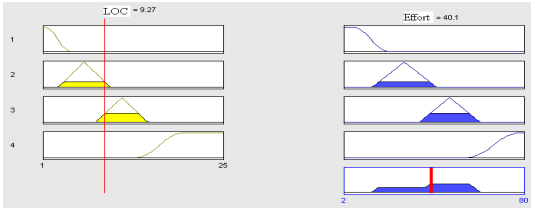

Fig.7 : Rule Firing Process

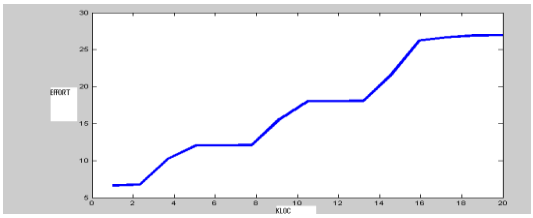

Fig. 8 : Surface Viewer

(III) Fuzzification of Boehm Simple Model:

At Last Very Populer Model For Software Effort Estimation i.e Boehm model is fuzzified for it's input and output for comparison with above mentioned models.

Data obtain from the formula of Boehm Simple model equation (iii) is used ones again to decide universe of discourse for KLOC and Effort.

membership for this model is show in Fig 9 and Fig 10 for KLOC and Effort respectably

Rule Firing process for KLOC =8.4 is show in Fig 11.

The Tow dimensional surface view for above model is show in fig 12 which clearly indicate the trends we may get smooth curve by increasing no of linguistic variable at hence by increasing number of rules.

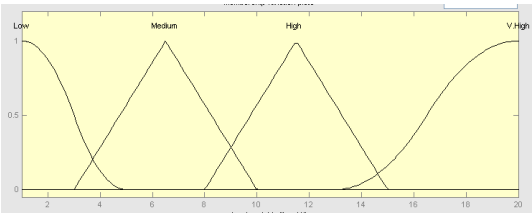

Fig 9 : Fuzzification of KLOC

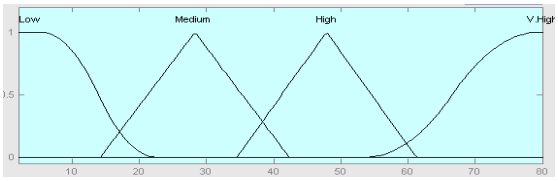

Fig 10: Fuzzification of Effort

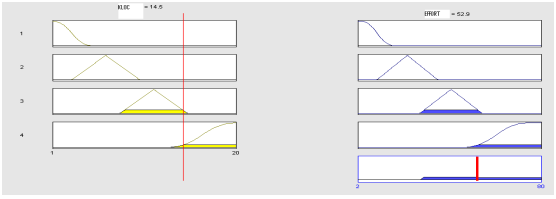

Fig 11 : Rule Firing Process

1. If (KLoc is Low) then (Effort is Low)
2. If (KLoc is Low) then (Effort is Low)
3. If (KLoc is High) then (Effort is High)
4. If (KLoc is V.High) then (Effort is V.High)

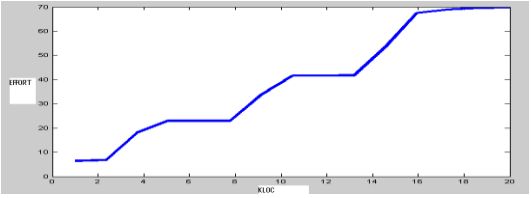

Fig :12 :Surface Viewer

5. Comparative Result

KLOC	Walstan Felix Model			Baily Basili Model			Bohem Simple Model		
	Cal. Effort	Fuzzy Effort	Error	Cal. Effort	Fuzzy Effort	Error	Cal. Effort	Fuzzy Effort	Error
I	II	III	IV	V	VI	VII	VIII	IX	X
1	5.2	4.7	0.5	6.23	6.8	0.6	3.2	3	0.2
3	14.1	13.9	0.23	8.11	6.9	1.2	10.1	9.7	0.4
5	22.5	21	1.49	10.2	12.1	1.9	17.3	18.6	1.3
7	30.6	29.8	0.75	12.4	12.1	0.3	24.6	23	1.6
9	38.4	37.6	0.8	14.8	15.2	0.4	32.1	32.5	0.4
11	46.1	45.9	0.19	17.2	18	0.8	39.6	39.2	0.4
13	53.7	53	0.66	19.8	18	1.8	47.2	46.9	0.3
15	61.1	60.9	0.22	22.3	21.9	0.4	54.9	53.6	1.3
17	68.5	66.9	1.6	25	26.6	1.6	62.6	61.2	1.4
19	75.8	73.9	1.9	27.7	26.9	0.8	17.4	17	0.4

Table 1
Comparision of Three different Empirical Model

Result obtain from above discussion is tabulated in Table 1. The Comparison of calculated and fuzzy effort for three different model is show in table 1. Calculated effort which is obtained from equation 1,2 and 3 for corresponding KLOC, While fuzzy effort is obtain by applying different KLOC. In the rule base using rule firing process (say for example for KLOC = 9.27 fuzzy effort for walston flex model obtain through fig 3 is 14.1) fuzzy effort for different KLOC (that is for KLOC = 1, 3, 5, 7, 9, 11, 13,15,17,19) is show in the table for all the three models and error is calculated using further formula

error = calculated effort – fuzzy effort……..(iv)

Error obtained in column no. IV , VII and IX are near to zero. Which clearly shows the efficiency of ffuzzy model of three different empirical software estimation model.

Since error is in acceptable range hence the fuzzified version of above model can be accepted , which will work in more precise manner then the hard computing formula explain in equation (i),(ii) and (iii). Fuzzy logic based model will work for a range of input value instead of any Sigel term value , hence will work in more precise manner and can be accepted.

6 Conclusion & Further Research

The work done in this piece of research work is fuzzification of three empirical software estimation models and its comparison. The table shows (Table 1) that result is satisfactory , this work can be further modified using another soft computing tool like Artificial Neural Network. Degree of Membership for KLOC and effort for three different models can be obtain and can be trained with a multilayer neural network (MNN) and result can be compared.

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