Software Reliability Modeling using Soft Computing Techniques: A Critical Review

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Abstract **-** Software reliability means the probability of a software to run in a given environment fault-free for a specific time period. The software is an integral part of various economic, manufacturing and military activities. With software application in many security systems, it has now become an important research area. One tool used to assess software engineering technologies is the measurement of software reliability. In the past 40 years, researchers developed many models based on software reliability parameters, such as the probabilistic variance, non-homogeneous Poisson process, and Bayes process, to assess software reliability. While in sometesting situations the models can efficiently calculate software reliability, no model can correctly estimate the software defects in all experimental conditions. In this paper, we discussed more than 100 research papers to analyze the software reliability models using soft computing. From this analysis, we find that the Neural network (NN) as the most suitable technique to find the reliability, and a lot of further research on cuckoo and the fuzzy logic of complex problems is required.

Index Terms— Software Reliability, Soft Computing, NN, Fuzzy Sets, Genetic Algorithm.

I. INTRODUCTION

The goal of software engineering is to create quality software that meets their specifications and is delivered on schedule and on budget [1]. In tech life, software creation plays a critical role along with its ever best quality prerequisites. The probability of fault-free performance over a specified time in a given setting can be known as the software reliability [2][3][4]. Software errors are implemented in multiple life cycle stages of developing software, application developers, programmers and managers. The program framework is checked to identify and erase these errors. The consistency of the information system is calculated by extracting these errors in terms of reliability. In many important and everyday implementations, software reliability modeling plays a major role, contributing to massive modeling work. These models were used successfully to quantify and forecast program errors. Users may use these templates to obtain access to existing and potential reliability and settle on the software, e.g., whether a system is usable to enhance software consistency in its present state or require extensive testing. "Software Reliability (EEE-Std 729-1991) is defined as the probability of failure free operations for a specified period of time in a specified background". Soft Analysis techniques are the series of numerous principles and techniques to solve real-world problems. It tackles the obstacles that seem inaccurate, ambiguous and hard to identify [5]. Weighty computation can be seen as an effort to emulate natural creatures: soft, agile, versatile and clever plants, animals. Soft computing is in this respect the name of a community of solving problems approaches in analogy in biological rationale and solving problems.

Soft computing consists of an artificial intelligence (AI) collaboration, which has been supported mainly by expert systems, fuzzy logic, ANN and GA [6]. The benefits of using soft computing consist in its capacity to accommodate inaccuracy, insecurity, and partial truth in order to accomplish observability and reproducibility in designed to simulate low-cost human decision-making [7]. The reliability quality of the software system is calculated by error deduction. Soft computing is used for basic computational paradigms like neural networks, fuzzy systems, and evolutionary algorithms [8].

II. LITERATURE REVIEW

The primary criterion in our analysis is that research on software reliability models is presented. Although the main purpose of this analysis is to guide and endorse possible reliability analyses, the other articles are mainly aimed at exposing the different structured reliability models to software experts or inexperienced reliability researchers. This difference in aim contributes to another emphasis. Our analysis focuses, for example, on testing approaches and does not provide an extensive overview of multiple software reliability methods.

A. Soft Computing

Soft Computing is helpful where reliable scientific instruments cannot have a low cost, analytical and detailed solution. Science techniques of earlier centuries may mere comparatively basic physical processes, classical Newtonian mechanics and engineering be molded and accurately analyzed [9]. Many complex cases e.g., biology and pharmaceuticals, arts, administration and related areas persisted, however, beyond the core region where detailed mathematical and methodological approaches have been effectively applied [10]. Diverse researchers have made considerable efforts to do this through the use of DOE, PSO, ANN and GA program techniques [11]. This paper provides literature analyses on the use of soft computing methods. The literature survey considered the study articles to provide a detailed summary of the investigation carried out by the different investigators. Resume the different methods used by the different engineering fields and currently coordinate the different research activities to provide relevant information for future research works.

III. SOFTWARE RELIABILITY MODELS USING SOFT COMPUTING

The principle has been suggested to solve problems related to classification and improvement by different SCTs including ANNs, FLs, Steam, PSOs and Hybrid shown in table 1. There are several studies which applied ANNs for software reliability prediction successfully. However, effectiveness of NN based prediction models depend on the type of dataset that is of changing nature [12]. Therefore, ANNs have the problem of overfitting the results. This happens when dealing with unknown data sets. Overfitting happens mostly because the model is well suited to training data, but the model output degrades with new data. The biggest concern with NNs is overfitting. The use of fluid logic systems is proven successful and definitive in the prediction of device performance [13]. The computational approaches based on FIS are more powerful than other soft computing techniques due to large computation and limited learning speed. The challenge is to make it more effective, though, with the use of modern technology that involve less resources and better forecast consistency [14]. A lot of authors have worked and use SRM using SCT to solve complex problem. In this section, they are preferred because they have the best mapping mechanism for real time situations. Some of the relevant and recent papers are mentioned here with their critical findings as shown in table 2.

Table 1: Summarization of Software Reliability Model using Soft Computing Techniques

S. No.	Author (s) Name	Topics	Model	Year of Pub	Reference
1	William W. Everett	Analyze software reliability using component analysis	Division Component Model	1999	[15]
2	Reinhard P.K Lemm, Martin Kappes andM.R. Kintala Chandra	Analyze reliability of component-based software system	Finite State Machine	2000	[16]
3	Dick Hamlet, Dave Mason	Calculation composite system reliability	Arbitrary Model	2001	[17]
4	Michael R. Lyu, Michael YuHuang, Jungen- Hua Lo, and Sy-YenKuo,	An overview of the reliability ofthe component-based software framework	Mathematical Model	2002	[18]
5	Mao Xiaoguang and Deng	General model component probability transition	Reliability Tracing Model	2003	[19]
6	Yacoub Sherif, Cukic Bojan, and Ammar Hany	Reliability model and technologiesfor component device reliability analysis	Scenario based Reliability Analysis (SBRA)	2004	[20]
7	Yoshinobu Tamura	open-source software	Neural Network and NHPPmodel	2006	[21]
8	WANG Dong, HUANG Ning andYE Ming	Extended reach to boost reliability evaluation accuracy	Markov Property	2008	[22]
9	Fan Zhang, Xing she Zhou	Sub domain-based analysis approach	Enhanced Compositionn Algorithms	2008	[23]
10	Gondra *et a.l*	Software metrics anda sensitivity analysis	ANN model	2008	[24]
12	Ate F Mohamed	Fault- tolerant component-based information systems reliability Quantificationon	Unmaskingand propagation	2010	[25]
13	Jagjit Singh *et al.*	Multi-agent-based decision Support System using DataMining andCase Based Reasoning	ANN model	2011	[26]
14	Aditya Pratap Singh	Reliability estimation model for a component-based system	path propagation probability	2012	[27]
15	Malhotra, *et al.*	Software Reliability is vital piece of software quality	ANFIS	2015	[28]
16	Cai *et al.*	Fuzzy Rationale derives from the principle	Probabilistic softwarereliability models (PSRMs)	2015	[29]
17	Khoshgofta ar et al.	Approach for static reliability modeling	multiple regression model selection	2015	[30]
18	Kuldeep Kaswan et al.	Reliability machine simulation using the technology of soft computing: critical analysis	Swarm Intelligence and Metaheuristic ic	2015	[31]
19	Vyas et al.	Faulty modules more effective and helps to obtain reliable software	Fuzzy sets	2017	[32]
20	Sahar et al.	an effective and appropriate method to measure the Software reliability growth model	GA	2017	[33]
21	Succi et al.	Assessment of software reliability is inevitable in modern software manufacture process	GQM approach	2018	[34]
22	Chander Diwaker et al.	A new model for the prediction of device component reliability	Component -Based Software Engineering (CBSE)	2019	[35]

23	R. Selvarani, R. Bharathi	Hidden Markov Model Approach for Software Reliability Estimation with LogicError	Hidden Markov Model (HMM)	2020	[36]
29	Jagjit Singh *et al.*	MAS CBRS's position forthe collection of	Swarm Intelligenceand Metaheuristic	2018	[37]
30	Kaswan etal.	Software reliability modeling using soft computing techniques: Critical review	-	2019	[38]
31	KuldeepSingh Kaswan	Fault Model for UML Behavioral Activity and Sequence Diagrams	Swarm Intelligenceand Metaheuristicic	2019	[39]

Table 2: Analysis of Software Reliability Model using Soft Computing Techniques

S. No.	SRM / SC	Description of results	Best suited	Evaluating of currentset of data collection	Quality improvement	Current data	Uses of critical and complex situational	Fact level of confidence	Evaluating	number of parameters
1	Probabilityof fuzzy events	yes	yes	no	yes	no	yes	medium	Yes	2
2	Approximat e reasoning	no	yes	Yes	yes	yes	yes	high	Yes	3
3	Randomized search	Not satisfactory	yes	yes	no	no	no	low	Yes	4
4	Evolutionary strategy	yes	yes	yes	yes	yes	yes	high	Yes	3
5	Support vector machine	yes	no	yes	low	no	medium	low	Less	2
6	Genetic Algorithm	partially	yes	partially	yes	no	yes	medium	Yes	5
7	Feed Forward NN	no	no	no	yes	no	yes	high	Yes	3
8	Recur Rent NN	no	no	no	yes	no	yes	high	Yes	1
9	ANN	no	no	no	yes	no	yes	high	Yes	4
10	Fuzzy sets	yes	yes	yes	yes	yes	yes	high	Yes	5
11	Dempster Shafer theory	yes	no	yes	yes	no	yes	high	Yes	3
12	Bayesian belief nets	yes	yes	yes	yes	no	yes	high	No	4
13	FL controllers generated tuned by ECs	yes	yes	yes	yes	yes	yes	high	Yes	2
14	FL controllers tuned by NNs	yes	yes	yes	yes	yes	yes	high	Yes	3

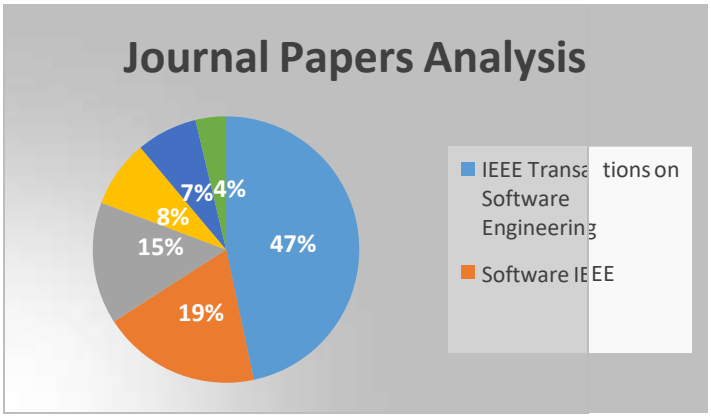

Figure 1: Analysis of paper published in Journals

The above figure-1 shows a lot of papers published in different journals. But maximum paper published in IEEE journal next maximum paper published in journal of system and science, Software IEEE is third one, Electronic and communication in Japan is fourth one and rest of papers published in Annals of Software Engineering Empirical Software Engineering. Every journal shows with proportion and cumulative proportion.

IV. CONCLUSION

In implementations, most of the methods of programme stability are

tested and therefore difficult to implement. In the current literature review for ascertaining software reliability, a large number of reliability models are proposed by the researchers in the past. A review of the literature reveals that the main reliability work was done at coding and testing levels at the stage of software development. This paper also discussed various reliability models of software reliability, and summarize researchers' work on the various parameter in the models of software reliability. From this analysis we find that the NN as the most suitable technique to find the reliability, and a lot of further research on cuckoo and the fuzzy logic of complex problems is required.

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