A Novel ANN based Approach for Reliability of Software using Object Oriented Metrics

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ABSTRACT
In the present scenario, software industries are facing lots of challenges and difficulties for software reliability. Test and measurement can be considered as reliable if they are producing same results over repeated time of quality testing. Software reliability acts an important role in the development of software in Software Development Life Cycle. There are so many factors and issues in SDLC that can affect the software reliability. Object oriented metrics provide a quantitative basis for planning and measuring software development process. Object oriented software design supports some of the basic design principals as encapsulation, cohesion, coupling and inheritance. This research paper is focusing on functionality and effectiveness of design phase which influence the software reliability in the object oriented software and of course, object oriented metrics determine how these matrices can reduce the faults and can increase the reliability of software.

Keywords
Software Quality, Reliability, Design Phase, Functionality, Object Oriented Metrics, ANN.

1. INTRODUCTION
Software Reliability is ability for computer program to perform its intended functions and operations in a system's environment, without experiencing failure or system crash [1]. Software reliability is defined as the probability of failure-free software operation for a specific period of time in a specific environment [2]. It is the capability of the software product to maintain a specific level of performance when used under specifies conditions [3]. Reliability is defined as the extent to which a questionnaire, test, observation or any measurement procedure produces the same results on repeated trials. The IEEE defines software reliability as "The ability of a system or component to perform its required functions under stated conditions for a specified period of time [4].

2. LITERATURE SURVEY
Chidamber and Kemmerer [5] proposed a set of six metrics in 1994 to identify certain design and code in Object Oriented software. Chand and Dhanda [6] proposed a model based on design and functionality properties and established several regression equations for computing the functionality of design hierarchies as functionality is positively affects reliability of object oriented design. Rosenberg, Linda and Lawrence Hyatt's [7] discussed the concepts and structures of OOM which generally affects the software quality. Johnny Antony's [8] describes the usefulness of object oriented metrics to estimate the reliability of software. Bansiya, Jagdish, and Carl G. Davis [9] described relationship between reliability factor functionality and object oriented properties. Highly functional software increases the reliability of object oriented software design.

3. METHODOLOGY
Factors affecting Reliability

This is considered as human beings can make errors during most of their activities and the developers who developing the software are human beings so there are more chances to make errors and software development is no exception case.

The quality of software is always a major issue and for that there are so many factors which can generally affect the software reliability and its quality [10]. In this paper we find out following factors in object oriented software, which may be affecting the reliability as

- **Lines of source code**
- **Inheritance of classes(Number of child classes in a class),**
- **Using appropriate methods inside the classes.**

To resolve these issues and to make object oriented software failure free, there are some important object oriented metrics LOC, CBO, NOM, and LCOM are used as input.

Object Oriented Metrics

Object-Oriented Analysis and Design of software provide many benefits such as reusability, decomposition of problem into easily understood object and the aiding of future modifications [11]. The functionality is strongly related to the reliability and plays an important role to deliver high class maintainable and reliable software with in time [6]. The functionality of design phase is dependent on design size (LOC), coupling (CBO), cohesion (LCOM), and complexity (NOM). Object oriented Metrics are considered as set of standards against which one can measure the effectiveness of Object-Oriented Analysis techniques in the design of a system [12]. So in this research paper object oriented metrics LOC, CBO, NOM, and LCOM are used as input.

LOC (Lines of Code)-

The LOC of a class is the number of all nonempty, non comment lines of the body of the class and all of its methods.

CBO (Coupling Between Object Classes)-

The CBO is a count of the number of other classes to which a class is coupled. It is measured by counting the number of distinct non-inheritance related class hierarchies on which a class depends.

The larger the number of couples, the higher the sensitivity to changes in other parts of the design and therefore maintenance is more difficult.

NOM (Number of Local Methods)-
It counts number of methods defined in a class. A method or message in Object Oriented Programming (OOP) is a procedure associated with an object class.

LCOM (Lack of Cohesion in Methods)-
It is defined as the number of different methods within a class that reference a given instance variable.

Neural Network Architecture
Artificial Neural Network a set of neurons and connections between neurons which is inspired by the ability of human brain to learn from observation and to generalize by abstraction [13]. Each neuron has an activation function processing the incoming information from other neurons.

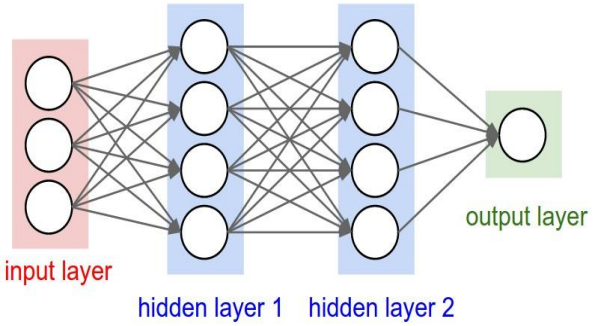

Fig.1 Artificial Neural Network

The general architecture of the Neural Network model is described in figure2. The model can be viewed as a directed graph composed of nodes, connections, weights (W1j, W2j …Wnj). A set of training vectors is presented to the neural network one at a time. The network generates one output by propagating the initial input variables through subsequent hidden layers to the final output layer [14]. Each neuron in the network computes a nonlinear threshold function of its inputs and passes the resultant value along its output.

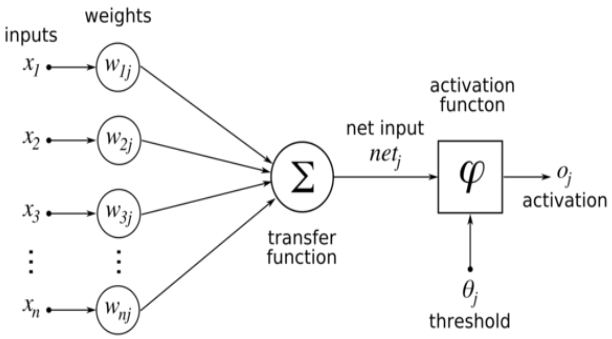

Fig.2 General architecture of Neural Network

The Back-Propagation algorithm

In order to train a neural network to perform some task, it is mandatory to adjust the weights of each unit in such a way that the error between the desired output and the actual output is reduced. This process requires that the neural network compute the **error derivative of the weights** (EW). In other words, it must calculate how the error changes as each weight is increased or decreased slightly. The back propagation algorithm is the most widely used method for determining the EW.

4. EXPERIMENTAL SETUP

In this research work, experiments are done on COMETS-Code Metrics Time Series dataset [15]. Dataset contains total 1424 records of various object oriented metrics. This dataset is filtered and refined after removing the extreme values, thus keeping only 881 records. This improved dataset is divided into two subsets DATA1 and DATA2 used for training and testing. In DATA1 records of 700 values are used and in DATA2 records of 181 values are used. From DATA1 and DATA2 only those object oriented metrics (LOC, CBO, NOM, and LCOM) are used which can affect the functionality of design phase of object oriented software.

It is measured by the literature reviews that the functionality and reliability are strongly associated with each other and functionality highly affects reliability of object oriented software [9]. So after evaluating the functionality, reliability can be measured and refine the data of each metric of each data set. After that evaluate the normalize values of each metrics by using the normalized function. Min-Max normalization performs a linear transformation on the original data. It maps the value of attribute in the range 0 to 1using the formula. The normalized value of e_i for variable E in the i^{th} row is calculated as:

$$Normalized\ (e_i) = \frac{e_i - E_{min}}{E_{max} - E_{min}}$$

Where, Emin is the minimum value for variable E.

Emax is the maximum value for variable E.

The data which is now normalized provided to Neural Network and create the network of the given data by using Feed-forward back propagation Neural Network Algorithm. In the given model TRAINLM is the training function, LEARNGDM is the adapting learning function and TANSIG

is the transfer function as shown in the figure 3.

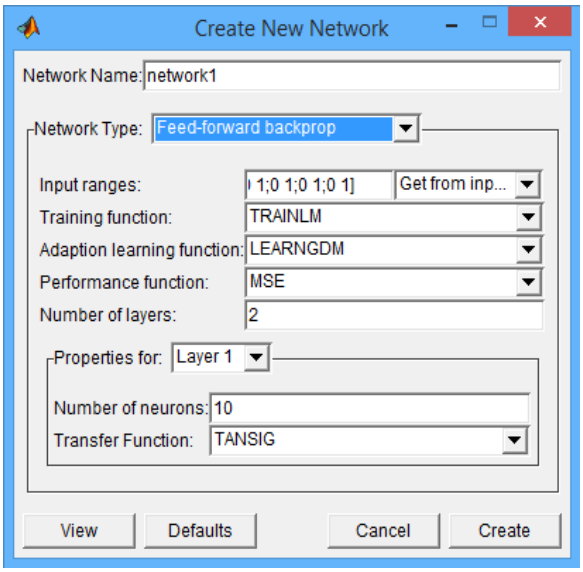

Fig. 3 parameters set for training

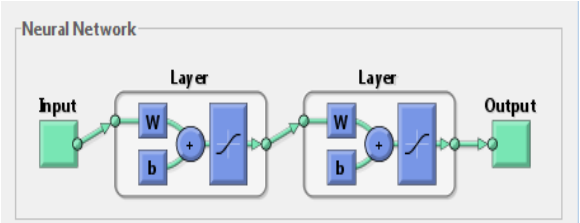

Fig.4 Architecture of Network

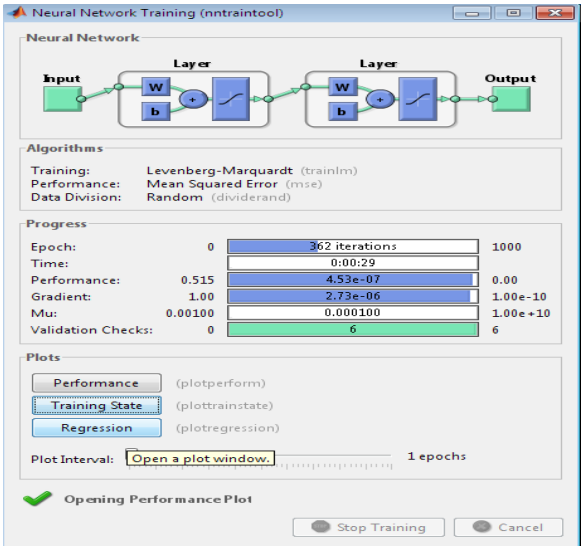

Fig. 5 Neural Network Training

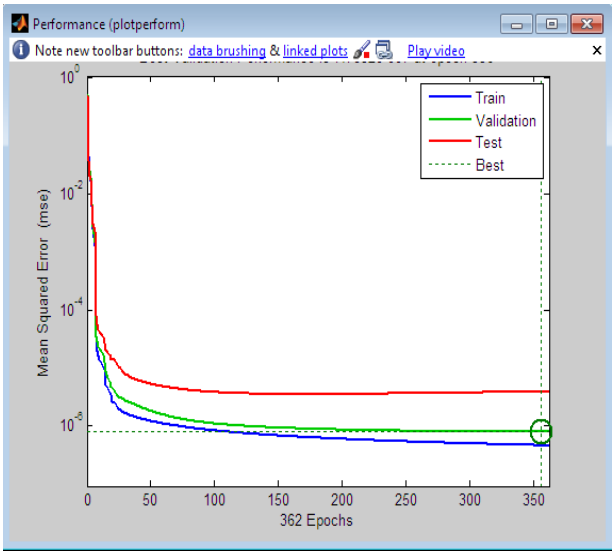

Fig. 6 Training performance by network

The performance of the proposed approach is measured by using RMSE method.

5. RESULT

In the research paper, experiments were performed in multiple times by changing the number of neurons for each iteration.

Neural Network Used	Training Function	Adaption Learning Function	Transfer Function	No. Of Neuron	RMSE
BPNN	TRAINLM	LEARNGDM	TANSIG	5	0.2826
				8	0.1917
				10	0.0998
				15	0.1569

Fig. 7 Tables of results in each iterations

The difference in results is compared for each neuron and finds the best result for the research work. Above table shows the obtained result in each iteration on different neurons. From the above statistics, it's clear that the best result of RMSE is .0998 for 10 neurons from the neural network.

6. CONCLUSION

This research paper present a novel approach of neural network to estimate the reliability of object oriented software using object-oriented metrics. Software functionality is an important part of design phase of software development life cycle which directly affects software reliability [9]. Software reliability is the probability of failure-free software operation for a specified period of time in a specified environment [10]. In this research paper, software functionality is considered as input affecting the software reliability. Software functionality can be evaluated by some of the object oriented properties so for that metrics design size (LOC), coupling (CBO), Cohesion (LCOM), and complexity (NOM) are used as input and evaluate reliability of software. The data of input metrics are applied on neural network and find out the efficiency of object oriented software by using root mean square. The obtained output is giving 9.98% error and 90.02% accuracy so from the research it's clear that the data of object oriented software is providing high reliability.

7. REFERENCES

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