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Prediction of Software Reliability Using Neural Network and Fuzzy Logic

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Abstract: *Software is often a key component of the high technology systems that are so common in modern society. It is a challenge to be able to enhance the quality a model early enough to prevent problems from fault later in the life cycle because it is much more cost-effective to correct software faults early in the development process than later when they cause failure. D. Whitley et al. (IEEE Tran. On Software Eng. 1992) stated that," the problem of selecting a model can be addressed in two ways: by generalizing the applicability of software reliability growth models by analyzing their predictability across a broad spectrum of representative data sets or by developing adaptive models. One approach proposed by Brocklehurst et al. (IEEE Trans. On Software Eng. 1990) is to try a set of model and selecting the one that best suit the situation. This is a trial and error procedure. It was claimed that different models have different predictive capabilities at different phases of testing and there is no single model that can be relied on for accurate prediction in all circumstances (Whitely et al. IEEE Tran. On Software Eng. 1992).*

I. Introduction

Many difficulties were reported that made analysis and design of such model a quite challenging process. For example: Missing data, large number of variables, strong co-linearity between the variables, complex non-linear relationship between model variables, outliers and small sizes of the data set, system identification and control, computer Network Design , image Processing and many others. Whitley stated that," The influence of the external parameters and other peculiarities of a model can be eliminated if we have a system that can develop its own model from the past failure history of the software system".

The **goal** is to develop better software reliability growth models using NNs and Fuzzy logic to improve accuracy of the Software Reliability Estimate.

II. Proposed Methodology for Modeling

The problem of software reliability modeling can be split to number of sub-problems: Selection of the model structure, Estimation of the model parameters. ANN's approaches found to be useful in many applications. For example: Prediction Cost Estimation, Software Reliability Engineering Strategy, Software size estimation.This is the methodology we are adopted in our current research. This is why we suggest building software reliability growth models using prior collected fault data.$y(k)=f(y(k-1), y(k-2),...., y(k-m))$
Where y(k) is the accumulated faults at instant k and m is the selected number of delays .

A Possible FF-NN Model Structure

It was claimed that RBF trains faster than a FF-NN and that produce a better decision boundaries (Leonard and Kramer 1991). The hidden layer in the RBF is easier to interpret than the hidden layer in an FF-NN (Leonard and Kramer 1991).RBF was realized by the Software Engineering Community as a useful tool for software engineering applications. For example, M. Shin and A. Goel have used RBF in software effort estimation for a well-known software effort dataset from NASA (IEEE Tran. Software Eng. Vol. 26, No. 6, June 2000).

A Possible RBF-NN Model Structure

IV. Fuzzy Logic

Fuzzy Logic approach has been successfully used to solve varieties of problems in modeling and identification of nonlinear systems. For the problem under study, it was found that the relationship between the predictive model input and output is nonlinear.

Advantages of fuzzy logic

- Fuzzy logic is useful when dealing with incomplete sets of data.
- Fuzzy set membership of data gives greater sensitivity for decision making.
- Fuzzy logic is useful when dealing with vague (unclear) information.

III. Evaluation of the model prediction capabilities

Whitley's NNs Model was build with the use of traditional model structure in mind which count on the execution time as a metric for predicting faults.

- Fuzzy Logic has been used in some preliminary work bythe Software Engineering Community as a useful tool for software engineering applications.
- For example, using a FF-NN with fuzzy weights to predict software reliability.

V.A Possible Fuzzy Model Structure

In our work, we propose a regression fuzzy model structure to predict accumulated faults. Using the set of input-output data we specify the number of clusters, we specify the number of rules. Then, estimate the fuzzy model parameters.

Evaluation (Fitness) Criteria

One can use the Sum of the Square of the Error as an evaluation criterion. One can also compute the Correlation Error in some cases. The well known criterion which have been extensively used by Software Engineering Community are:

The Average Error and the Average Bias

VI. Conclusion

High reliable software is critical both to software producer and users, as well as society. In general, because failures of software can cause major disruption to business and can even threaten emergency service. It is a challenge to be able to enhance the quality a model early enough to prevent problems from fault later in the life cycle because it is much more cost-effective to correct software faults early in the development process than later when they cause failure. This is why building software reliability growth models have gained considered importance in assessing reliability of software products. FF-NN, RBF NN and Fuzzy logic models out perform the tradition software reliability growth model. FF-NN, RBF NN and Fuzzy logic models were able to provide models with smaller SSE than regression for all studied projects.

Mean Magnitude of Relative Error

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