Maintainability Prediction for Software based on Class Diagram using Back Propagation Neural Network and Coco Search Algorithm

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ABSTRACT
accuracy and Software quality impacts user satisfaction and development costs. Maintainability has gained its importance as a factor of software quality and the need for early indicators of external quality attributes is a critical necessity. Maintainability of object-oriented software can be predicted through the implementation of advanced modeling techniques. This paper presents a model to predict the understanding and modifiability as standard maintainability software from class diagram using the Back propagation neural network with the Coco search algorithm. The results of this model are compared to multiple linear regression models. The results reported that the integration between Back propagation neural network with the Coco search algorithm is an improved maintainability expected with higher accuracy.

Keywords
Maintainability, Back propagation neural network, Prediction, understanding, modifiability, Cuckoo search algorithm

1. INTRODUCTION
At present, many software engineers are an important factor: software quality. The maintainability process in early stages of the system is difficult because it contains a set of measures that must be accurately calculated, maintainability can be calculated at early stages of the system, for example at the design stage (design for object-oriented) for greater reliability, always quality Prediction Indicates Predicting maintainability or reliability of program. When designing a software product, it should be subject to a set of measure and the quality scale is considered to be the highest[1], maintainability is considered one of the most important quality metrics and a key criterion used by the institutions and evaluation centers of the software products in evaluating the economic success because maintainability reduce the time and effort in the maintenance phase. The software engineer must be familiar with the design components and how they work together to ensure high reliability.

the Studies of Statistics from different institutions show that between 40% and 80% of the Regular software development expenditure is You go in the maintenance phase where the software is updated, the errors are Repair, Development the performance to meet changing field requirements[2], When the completion of the construction of any software product delivered to customers and start the product work, and may be some errors during the operation here begins maintenance phase to keep the system functioning properly and maintenance is a set of activities carried out by the maintenance team. Many research works were conducted to predict the extent of maintainability. To compute it, the Engineer needs to identify the required modifications by identifying the factors affecting the system to suit the desired change. It is also known that software maintenance time, and Maintenance takes longer than development time[3]. This paper performance of the proposed Cuckoo Search Back-propagation (CSBP) to predict software maintainability of object-oriented system (class diagram). Been relied on attributes understandability and attributes modifiability class diagram to predict their maintainability because they (understandability and modifiability) are considered the most important qualities of maintainability, and then comparisons of results with the technique of multiple linear regression.

2. RELATED WORK
Several researches of the most up-to-date empirical studies about to Maintainability metrics:

Rizvi et al.[2010],[4], developed a multivariate linear model in design(Object-Oriented software) phase for estimate the maintainability of UML class diagram in terms of understandability and modifiability.

Dubey .S et al.[2012][5] they used artificial neural networks(Multilayer Perceptron MLP) to predict maintainability of program and compare their results with other models and achieved the advantage.

Momeni .H and Zahedian .SH (2014)[3] They suggested predicting the maintainability of aspect-oriented software by model ANFIS and Their results compared to the fuzzy logic model were the best.

Kumar .L and Rath .S(2015)[6] they estimate software maintainability using hybrid of neural network and genetic algorithm. And compare Their results With the results of neural networks and gradient descent, Their results was best.

Asadi .M and Rashidi .H(2016)[7] They suggested a new model to predicate the maintainability depend on the measurements of new metric use summation for metrics and criticisms of the regression analysis, And applied their model on famous PHP framework and Their model was the best.

3. MAINTENANCE
Maintenance is the precautionary measure to maintain or restore the an entity to normal or validating it to protect from failures. The need for maintenance is necessary to modify a product after delivery to correct existing defects, improvement of the system performance and conditioning of the software to the newer environment. Most researchers classified maintenance as adaptive, corrective and preventive [8].
**a Adaptive Maintenance**: should be used. This environment-based maintenance if there are modifications to devices, operating systems, files or compilers that have an impact on the system.

**b. Corrective Maintenance**: his error-driven activity is. Resembles to the debugging process and occurs after the system is started. During a complete life cycle of corrective maintenance of the system is required because programs are prone to error in nature.

**c. Preventative Maintenance**: It is used to Become the software more maintainable by update the documents, Changes made to the program product modification after delivery to detect and correct underlying errors [8].

4. **MAINTAINABILITY**

According to IEEE standard Special of software engineering, maintainability is “The ease with which a software system or component can be modified to correct faults, improve performance or adapt to a changed environment” [9], maintainability is largely affected by the object-oriented approach of a system and the system is easily maintainable if at the design phase [10], an object-oriented system is decomposed into components and each component is further decomposed into sub-systems. Thus, a system is Considered to be maintainable if the change Impact less number of sub systems .there are a set of scales for measuring the structural complexity of class diagram and to use this scales for predicting their maintainability. However, wide range adaptation of class diagram metrics in many application domains should only Occurs if the metrics are valid, meaning that it accurately measures the features of the software that are designed for measurement and has been verified experimentally [11]. a set of metrics show in Table 1 [12] has been selected for Appreciation understandability and modifiability of class diagram metrics.

**Understandability**: of the software system defines as the attributes of the program that uses the user efforts to identify different logical concepts. understandability of the software system Indicates the user requirements, state of their Acts.

**Modifiability**: When the system needs to increase its performance to meet the requirements of the system developer then need to change the system tasks and this happens by changing the characteristics of the system to fit the performance increase. These changes are called modifiability[13]

**Table 1: Measures of structural complexity for UML class diagram**

<table>
<thead>
<tr>
<th>name of Metric</th>
<th>Definition of Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>sumC</td>
<td>Sum of The classes</td>
</tr>
<tr>
<td>sumA</td>
<td>Sum of The attributes</td>
</tr>
<tr>
<td>sumM</td>
<td>Sum of The methods</td>
</tr>
<tr>
<td>AssocN</td>
<td>The associations number</td>
</tr>
<tr>
<td>sumAgg</td>
<td>The sum of aggregation relationships within a class diagram</td>
</tr>
</tbody>
</table>

5. **PROPOSED WORK TO FORECAST MAINTAINABILITY**

This section Shows the Merge between techniques of artificial intelligence (AI) for predicting maintainability. Where the merge between cuckoo search algorithm and Back propagation Neural Network. 

**5.1 Back propagation Neural Network (BPNN)**

The BPNN is One of the most famous networks under supervision for its ease, and its ability to store information implicitly in links. The weights that connect one cell to another and learn BPNN are calculated by compute output layer errors to find errors in hidden layers. The back propagation neural network Contains of at least three strata of cells: the input strata, the hidden strata, and the output strata [6] and figure (1) explain the Back propagation architectural. with a reverse spread and although this network has been successful in many But it is not the panacea for all issues, for example complex issues need to be resolved Time is too big.

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**Fig 1: architectural of the Back propagation neural network**
5.2 Cuckoo search algorithm CSA

This algorithm depends on the behavior of the bird in the encroachment and placing its eggs in the nests of other birds as brood parasitism, “CSA is enhanced by the Levy flights which give it more potential than evolutionary algorithms”[14], CSA job Accredit on the following three steps:

1. Each cuckoo bird at a time puts the an egg in the occupied nest
2. The nest with the better type of eggs will turns up for new generation, and the minimum type will be Neglected.
3. The total number of occupied nests is repaired. when Owner of the nest can reveal a cuckoo’s egg , then Crash the nest and create other nest.

In a mathematical way, basic rule is a random procedure Featuring by Levy flights. While a next solution generate, 

\[ x_j^{(i+1)} = x_j^i + a \text{ levy}(h) \] ……………………(1)

Where a is a positive value whose size change depending on the optimization sample, Levy Flights is a random gait that is features by a set of right jumps , and i appear the present generation

5.3 The Proposed CSBP Algorithm

In this research an algorithm was applied an algorithm cuckoo search (CS) with Back propagation(BP) Neural Network, to find the best weights for the Metrics in table1 to compute understanding and modifiability that are considered to be the most important standards of Maintainability, and Figure 2 illustrates the proposed CSBP algorithm

the BP Neural network considered successful in many applications but is subject to a problem Network paralysis The result of the wrong selection of weights, especially if weights were chosen large numbers, it means The change in these weights will produce very large numbers, leading to the fact that all or most of the cells in the network produce significant values for real output While the activation function is derived with small values This leads to grid paralysis, so you should choose small initial numbers for weights and reduce the learning rate But training time will increase. And by doing a number of tests It turns out that if the learning ratio is too small, this leads to approaching the solution The correct will be very slow, but if the learning ratio is too large, this leads to paralysis of the network. And to solve all these problems in the BP network and accelerate its work has been It was used with an Cuckoo Search algorithm,

In the proposed Cuckoo Search Back propagation algorithm (CSBP) each better nest representations a possible solution .The quality of the solution see in the volume of population and issue of weight improvement , In the first phase, Using an CS algorithm the weights are initialized and these weights are considered to be introduced to BPNN where they are updated and the weights are calculated optimally. The weights in BPNN are compute according to the equation (2,3) and find rapprochement with best solution in the backward direction, Where it was used sigmoid as activation function of efficiency used in the network Back propagation ,that is described as a simple derivative, used in the implementation of the algorithm.
Output = \( f(\text{NET}_j) = \frac{1}{1 + e^{-\text{NET}_j}} \) \hspace{1cm} (2)
\( f(\text{NET}_j) = \text{output}(1 - \text{output}) \) \hspace{1cm} (3)

In the next stage, CS is done depending on the best result and continue work to find the weights until the error rate is less than 0.001.

6. COMPARISON OF RESULTS

Data set used during the study has depends on search Genero et al. [12]. It consists of eleven metrics (show in Table 1) to predict understandability, modifiability for maintainability, after applying the proposed CSBP algorithm on this data from 28 class diagrams, the optimal weights were obtained for the metrics shown in Table 1 to predict understandability, modifiability, the figure(3) show the results obtained from applying the CSBP algorithm proposed to predict understandability with the actual results and figure(4) show the results obtained from applying the CSBP algorithm proposed to predict understandability with the actual results and the results achieved by Rizvi S et al [4] Using multiple linear regression, the figure(5) show the results obtained from applying the CSBP algorithm proposed to predict modifiability with the actual results and the results obtained from applying the CSBP algorithm proposed to predict modifiability with the actual results and the results achieved by Rizvi S et al [4] Using multiple linear regression, and the table (2) show correlation values between the values calculated using the CSBP algorithm for the (understandability, modifiability, maintainability) and the actual values are strongly correlated.

7. CONCLUSIONS AND FUTURE WORK

In this paper a new algorithm was introduced based on the integration of the Cuckoo Search algorithm with Back propagation Neural Network algorithm to obtain optimal weights for the metrics used to predict external quality characteristics such as maintainability in the initial stages of the life cycle of the system is class diagram, and the error ratio for BPCS algorithm was 0.001. The results were compared with the results of research by Rizvi S et al. Using multiple linear regression, and it was found that the proposed algorithm achieved better results to predict the characteristics of maintainability such as: understanding and modifiability, analyzed the results using the Pearson’s correlation. It was found that the weights values for each metric are closely related to the characteristics of maintainability such as: understanding and modifiability.
In future work, can be applied are sub-characteristics of maintainability such as flexibility and extendibility. On artificial bee colony algorithm or other algorithms.

8. REFERENCES


[7] Software Metrics Suite, Recent Advances in Information and Communication Technology 2015


