CHAPTER 7

CONCLUSION

7.1 INTRODUCTION

The surge of OO programs and increased adoption rate of OO paradigm has led to the introduction of new measures and modeling techniques for this environment. The main aim of this approach is to correlate the internal software measures to the external quality attributes like reliability, maintainability, understandability and testability. Research work in this direction results in a good prediction model that can be used as a managerial decision making tool, especially during software development.

Several research works have been performed in this area in a relatively short span of time. This is due to the popularity of OO environment. The ultimate goal of the best measures and models is yet to be achieved. Hence an investigation has been carried out in this research work and new ideas have emerged which take the research further in the same direction. The newly introduced High Precision Cohesion Metric, Artificial Neural Network models trained using swarm intelligence algorithms give better results. This chapter presents a summary of the results obtained as part of this research work and suggests problems for future research investigations.
7.2 CONTRIBUTIONS OF THIS WORK

- An evaluation model is proposed for the OO metrics. The language feature function in the evaluation model can be applied to any already available or new OO metric for evaluating their suitability to OO languages. The metrics can also be adapted if there exists an equivalent functionality that the metric is based upon.

- An automated tool is proposed to compute the OO metrics. The tool is designed to be extensible by adding new OO metrics and OO languages as plug-in modules. The tool follows standards from Object Management Group. This makes the automated tool to be flexible and also compatible with other modules that use OMG standards.

- Various data sets are considered in this research work – standard libraries, open source systems, software developed by students in an academic institution and NASA dataset in public domain.

- A new cohesion metric is proposed to address the limitations of existing cohesion metrics. The proposed metric identifies the strength of connections between method pairs. The new metric is analyzed for its contribution to cohesion by capturing a new dimension not previously covered by existing cohesion metrics.
• The new cohesion metric is theoretically validated by analyzing its relationship with other class characteristics. This is carried out with the help of correlation study using Pearson coefficient. The results indicate HPCM has an inverse relationship with size metrics, LCOM and CBO.

• The proposed cohesion metric is empirically validated using the Chidamber and Kemerer metric suite. The LCOM metric in the suite is replaced by the proposed cohesion metric and the improvement is analyzed in the prediction of fault proneness and fault counts. Similar experiment is conducted by replacing LCOM with another cohesion metric, Cohesion Count. It is found that the prediction performance using the proposed cohesion metric is higher compared to the LCOM metric and the Cohesion Count metric.

• A new attempt is made to compare the performance of various swarm intelligence algorithms in training ANN for OO fault prediction models. Prediction models are developed based on Artificial Neural Network and trained using four different swarm intelligence algorithms. The results confirm that neural network trained using swarm intelligence algorithms yield better prediction results compared to the network trained using gradient descent. The swarm intelligence algorithms are compared for their prediction accuracy and performance attributes in training neural network.

7.3 SUGGESTIONS FOR FUTURE WORK

The following problems have been identified for further investigations.
- The empirical validation for HPCM is performed using open source code in Java. This data set may not be representative of real time large object oriented software systems. A thorough validation has to consider programs of different sizes and types and from different domains. This can be taken up as an extension of HPCM validation.

- Another potential area of research include, applying HPCM along with other metrics to evaluate software quality and compare the effectiveness of the metric in industrial software.

- The concepts used in HPCM can be extended to present a complimentary metric for coupling between classes.

- A subset of the available swarm intelligence algorithms has been considered for this study. The experiment can be carried out with other swarm intelligence algorithms. This could yield models that have better fault prediction accuracy.

- In this work the focus is only on finding the optimal weights for an ANN using swarm intelligence algorithms. Swarm intelligence algorithms can be used to find the optimal values for other parameters of ANN.

- Swarm intelligence algorithms have been used individually to find the optimal weight values. Combinations of swarm intelligence algorithms can be experimented.

- The dataset considered for this study have been taken from the NASA public dataset. Future work could include dataset from industrial projects for a fair comparison.
• A heuristic study for choosing appropriate parameters for the training algorithms needs to be done.

• The proposed Automated Metrics Tool (AMT) has been verified against student projects. It can be extended to include verification against benchmark data.