 ISSN : 0976-8491 (Online) | ISSN : 2229-4333 (Print)

A Hybrid Approach Using GA and ACO for Risk Assessment in Bank Loan Process

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Abstract
Risk assessment has been one of the major areas of research in banking. The main purpose of assessing credit risk is to differentiate between a potentially default customer and non-default customer. The work presented in this paper focuses on calculating risk assessment value by using Genetic Algorithm and Ant Colony Optimization Algorithm. The modelling of bank loan process that a banking organization follows is done by using BPEL (Business Process Execution Language). The outputs of this method are important for reusability purpose.

Keywords
Risk Assessment, BPEL Process, Genetic Algorithm, Ant Colony Optimization Algorithm, Software Reusability

I. Introduction
Credit risk assessment is widely studied topic in banking industry. From the ancient times it is very difficult to assess the risk associated with a loan process. Credit risk assessment is a basic task in credit risk management it is basically a classification approach. Its main task is to analyze the credit risk of banks and differentiate between good and bad customers. Rejecting a good customer and accepting bad customers is not acceptable as both effect the bank financial bottom line. So there is need to process loan as fast as possible but giving loan to the right customer only [1]. For all banks, credit risk is main risk. Studies show that main reason for bankruptcy is credit risk. In recent years, a number of banks around the world made several models in attempt to assess credit risk [2-3]. In recent times a new approach has been used to assess credit risk i.e. optimization algorithms. This paper applies the hybrid approach of genetic and ant colony algorithm on bank loan process. In this approach we use UML diagram of bank loan process and convert that into business process language. The main focus is to calculate assessment value and measure the risk associated with the process. And also compare the results with previous methodology. This paper is organized as follows the next section give overview of related work. Section III presents research method and section IV presents result and comparison. Section V presents conclusion.

II. Related Work
Credit risk management is defined as identification, measurement, monitoring and control of risk arising from the possibility of default in loan repayments [4]. Bank gives loan to the borrowers thinking that they will pay back their loans on time, but some borrowers failed to do so and as a result, banks income decreases due to the need to provision for the loans. Where commercial banks do not have an indication of what proportion of their borrowers will default, earnings will vary thus exposing the banks to an additional risk of variability of their profits [5]. To overcome this problem commercial banks around the world use various models to evaluate credit risk. Many authors proposed number of methods to evaluate credit risk. In 1996 [6] proposed a k-nearest neighbor methodology. The author compared his results with other classification techniques like linear, logistic regression and decision tree. Results showed that k-nearest neighbor perform well than other techniques. It achieved the lowest bad risk rate. In 1999 [7] investigates a solution to credit analysis problem. This paper proposed a neural network based credit scoring system for the retail business in Brazil. This new credit scoring system automates the process of decision making. An actual database of customer is used to implement the system. Results show that proposed system is better than the traditional discrimant analysis system. The proposed system is also very flexible; it can easily adapt changes being made to the system. In 2001 [8] developed a bankruptcy prediction system using neural network. This paper proposes novel indicators for neural network system .Results show that use of these indicators improve the prediction accuracy of the system (from 81.46% to 85.5% for a three-year-ahead forecast.). In 2002 [9] proposed a credit risk assessing and forecasting model based on artificial neural network system. Experimental result shows that this new system measures the degree of risk exposure and the probability of bad debt in accurate way. In 2009 [10] propose a probit regression and neural network model based decision tool for bank in order to distinguish between bad and good creditors based on number of days of delay in payment. For credit risk evaluation in 2011 [11] proposed a new hybrid decision support system using genetic algorithm and MLP neural network. This method was applied on real case study of Mellat Bank (Iran). Experimental results showed that the proposed model has better functionality and robustness than other quantitative methods like neural networks and statistical methods in terms of number and type of errors. In 2013 [12] generated automatic test cases of BPEL process by using artificial bee colony optimization. They use the example of bank loan process and book order process. The results show that it presents better results than TCSSLS method and random test case generator. ABC approach has better performance than TCSSLS and ABC method also reach same transition coverage by generating lower number of test cases. In the same year [13] used supervised neural network for the prediction of customer loan default. The investigation is done under different training algorithms scaled conjugate gradient backpropagation (SCG), Levenberg-Marquardt algorithm (LM) and One-step secant backpropagation (OSS). This paper also compared two filter functions and evaluation of the ensemble model. In this paper several parameters are used to do this comparison training time, iteration, MSE, R. Results shows that the best algorithm is LM and slowest algorithm is OSS.

III. Research Method
For this methodology we used MATLAB 7 for implementation. Following diagram in fig. 1 shows the proposed methodology. We first take a UML diagram of bank loan process and then from that diagram business process is created.

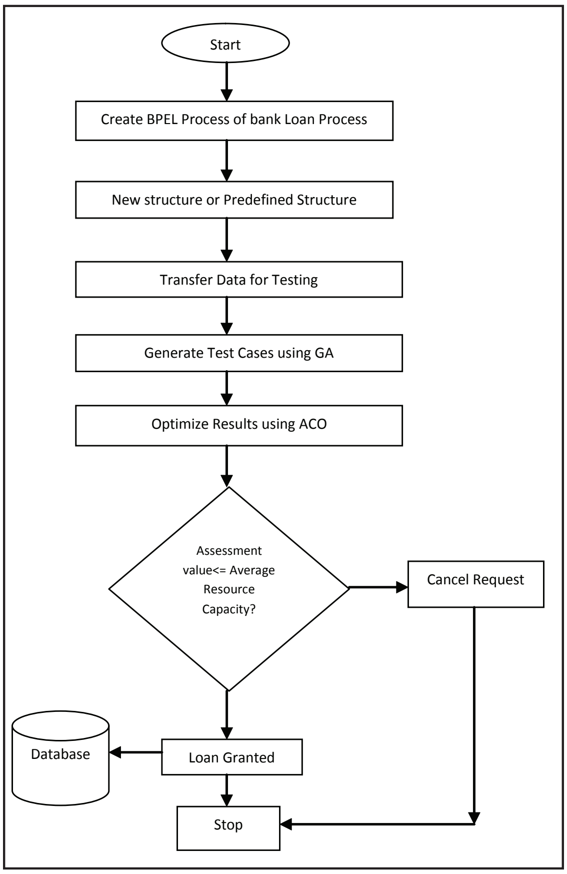

Fig. 1: Flow Diagram of Research Methodology

Step 1: First a loan application from a customer is received and then loan process is converted into BPEL process i.e. Business Process Execution Language. For this purpose we can manually add all the base tags or we can upload the predefined BPEL structure of bank loan process. Fig. 2 and 3 shows the creation of new structure using base element and sub root element. And figure 4 shows the predefined structure.

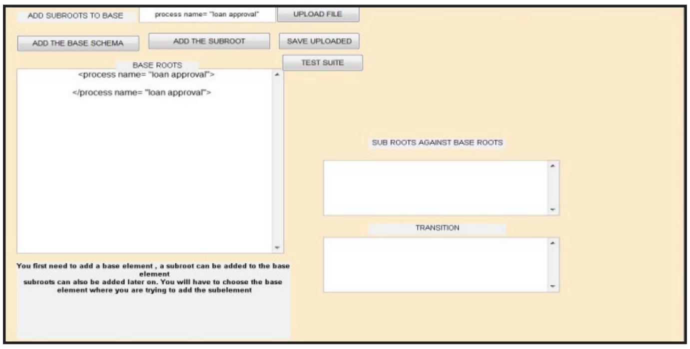

Fig. 2: Addition of Base Element

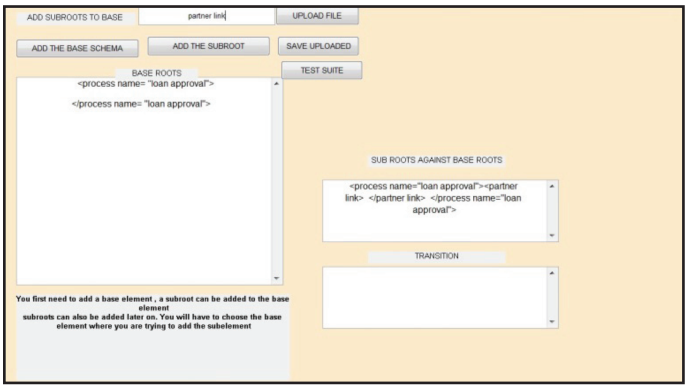

Fig. 3: Addition of Subroot Element

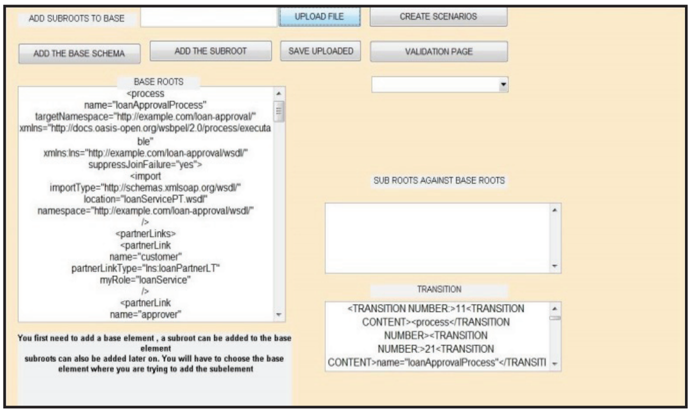

Fig. 4: Predefined Structures

Step 2: Once all data will be entered into the system. Then it will prepare for testing. At this stage data will be converted into a suitable form that is acceptable by genetic algorithm. Fig. 5 show that data is ready for testing.

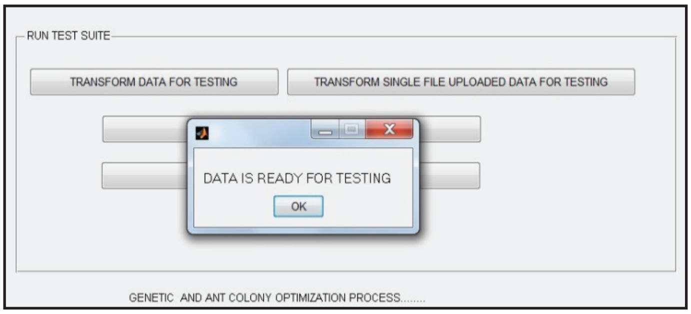

Fig. 5: Data is Ready for Testing

Step 3: Output of step 2 will be used as input for genetic algorithm. Genetic algorithm (GA) generate test cases and from those test cases it will give optimal test suite and assessment value. It also computes time consumption. Fig. 6 show the time consumed by GA. Fig. 7 show the accuracy matrix.

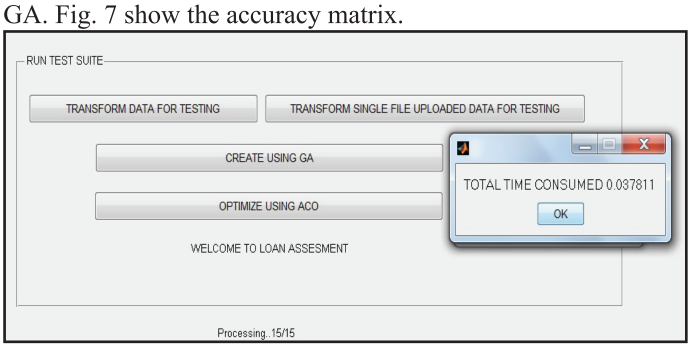

Fig. 6: Time Consumed by GA

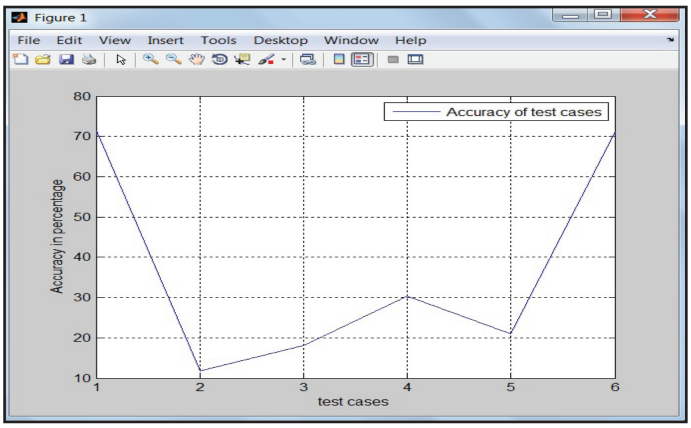

Fig. 7: Graph of Accuracy Matrix

Step 4: These test cases generated by genetic algorithm (GA) are further used by ant colony optimization algorithm (ACO). ACO reuse output of GA and optimize the assessment value given by GA. System will check comparison between assessment values of ACO and GA. if the difference is less than 30 % means risk is low then the loan will be granted to the customer and assessment value saved in the database. If difference is more than 30% means risk is high so loan will not be granted to the customer .ACO also optimize the test cases generated by GA. Figure 8 shows the loan is granted.

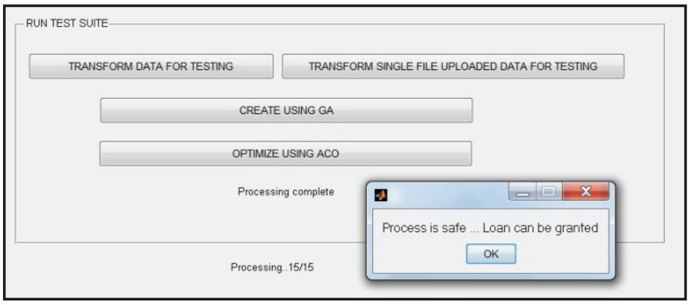

Fig. 8: Loan Granted

Table 1 shows the assessment value evaluate by genetic and ant colony optimization algorithm.

Table 1: Assessment Value

Type of Creation	Assessment Value(GA)	Assessment Value(ACO)
New Structure	101.8333	101.8108
Predefined	70.2500	70.2274

Step 5: For future reusability of these results, the results of ACO i.e. assessment value will be stored in database. This database will be managed by Risk analyzer component. If the assessment value is already stored in database then system will not check comparative analysis. And if the value is new then after comparative analysis output will be stored in the database so that in future we can reuse it.

Step 6: End of process.

IV. Results and Analysis

In this paper results are compared with artificial bee colony (ABC) methodology. Table 2 shows comparison between two methodologies.

Performance parameters: these are the performance parameters that are measured during implementation.

A. Accuracy

Accuracy is how close a measured value is to the actual (true) value [14].

B. FAR (False Acceptance Rate)

A system's FAR typically is stated as the ratio of the number of false acceptances divided by the number of identification attempts [15]. FAR is also known as type II error.

C. FRR (False Rejection Rate)

A system's FRR typically is stated as the ratio of the number of false rejections divided by the number of identification attempts [15]. FRR is also known as type I error. Table 2 shows the output value of accuracy, FAR and FRR of GA, ACO and ABC.

Table 2: Results

Parameters	ACO	ABC
Accuracy	99.0179	83.3333
FAR FRR	0.98199% 9.258%	16.503% 0.16363%

Below are the graphs of accuracy, FAR, precision, recall and FRR of GA and ACO methodology.

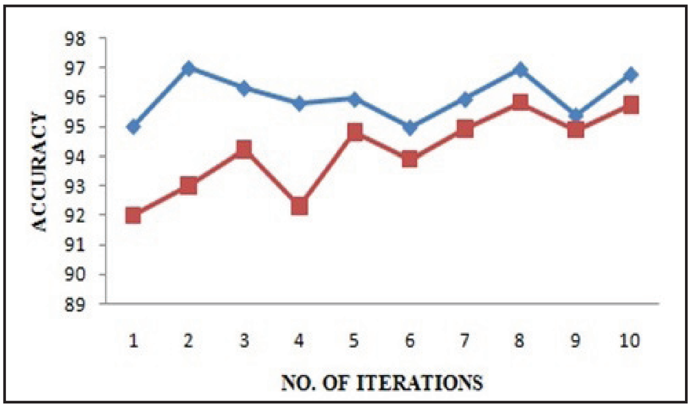

Fig. 9: Graph of Accuracy

Fig. 9 shows the graph of accuracy. X-axis represents number of iterations and y-axis represents accuracy. Blue line shows the accuracy of present work and red line represents the accuracy of ABC algorithm.

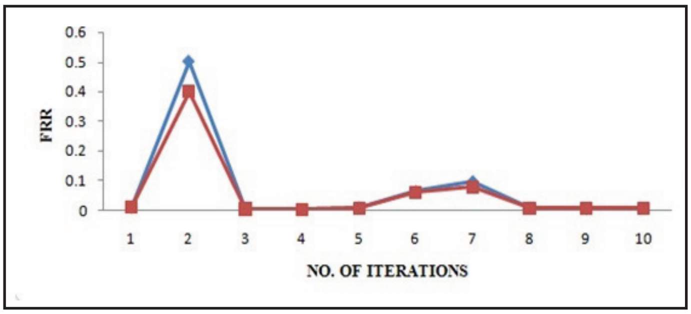

Fig. 10: Graph of False Rejection Rate

Fig. 10 shows the graph of false rejection rate (FRR). X-axis represents number of iterations and y-axis represents FRR. Blue line shows the FRR of present work and red line represents the FRR of ABC algorithm.

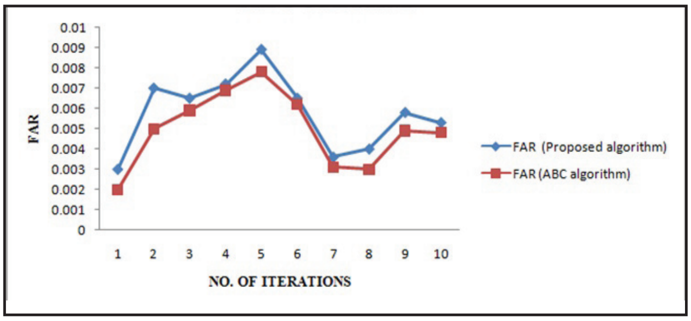

Fig. 11: Graph of False Acceptance Rate

Fig. 11 shows the graph of false acceptance rate (FAR). X-axis represents number of iterations and y-axis represent FAR. Blue line shows the FAR of present work and red line represents the FAR of ABC algorithm.

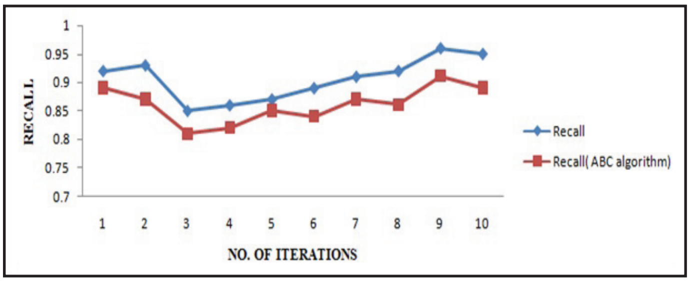

Fig. 12: Graph of Recall

Fig. 12 shows the graph of recall. X-axis represents number of iterations and y-axis represents recall. Blue line shows the recall of present work and red line represents the recall of ABC algorithm.

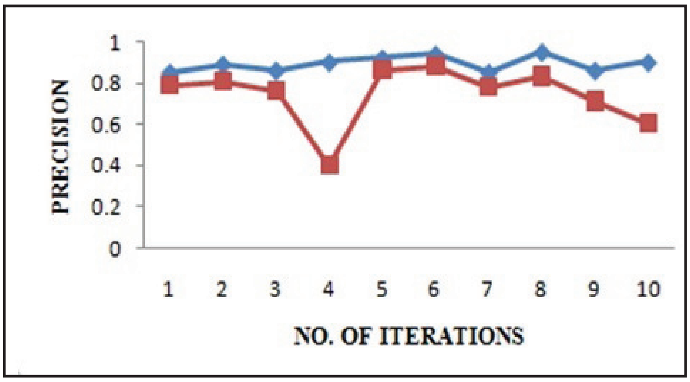

Fig. 13: Graph of Precision

Fig. 13 shows the graph of Precision. X-axis represents number of iterations and y-axis represents precision. Blue line shows the precision of present work and red line represents the precision of ABC algorithm.

V. Conclusion

Overall results show that genetic and ant colony optimization hybrid methodology is better than previous existing methodologies for example ABC. In this paper results of GA and ACO methodology are compared with ABC (artificial bee colony optimization). Accuracy of our method is better than ABC method. This approach outperforms the ABC methodology in accuracy, FAR and FRR. The accuracy of our methodology is 99.01 % and it is 15 times better then accuracy value given by ABC. There is a huge difference between FAR values of GA, ACO and ABC methodologies. GA and ACO also generate optimal test suite of test cases.

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