HOUSING LOAN EVALUATION SYSTEM USING ARTIFICIAL NEURAL NETWORK

AZMI RAIF NUR B ABD WAHAB

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Faculty of Computer System & Software Engineering

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ABSTRACT

Nowadays, billions of Malaysians are engaged to at least one housing loan contract when they buy their own houses, and thousands are still applying. A lot of work has to be done by the loan companies (banks) in order to determine the affordability and possibilities of payment. The use of artificial intelligent integrated system is widely known nowadays as it helps to lessen human burden with its effectiveness in making analysis and prediction. Therefore, the Housing Loan Evaluation System is developed to suits the need of the loan companies (banks) in making analysis generally. This system takes a list of factors related to the loan as inputs. Then, it filters out and sorts them according to the importance level. After that, the artificial neural network is used to make an evaluation and from the result, the company can choose to approve or not to approve the loan application.

ABSTRAK

Zaman masa kini menyaksikan ribuan warga Malaysia yang terikat kepada sekurang-kurangnya satu kontrak pinjaman perumahan sewaktu mereka membuat pinjaman, dan ribuan juga yang masih dlm proses penilaian. Banyak kerja penilaian yang harus dilaksanakan oleh pihak pemberi pinjaman untuk mendapatkan kemungkinan kelayakan bagi satu-satu permohonan. Penggunaan system berdasarkan Artificial *Intelligent* amat popular zaman ini kerana ia membantu mengurangkan tenaga kerja manusia melalui penghasilan analisis dan ramalan yang efektif. Oleh itu, *Housing Loan Evaluation System* dibina untuk membantu pihak pemberi pinjaman membuat analisis. Secara keseluruhannya, sistem ini mengambil faktor-faktor berkait sebagai input, membuat tapisan, menyusun mereka mengikut kepentingan, dan akhirnya membuat penilaian bagi pihak pemberi pinjaman untuk memilih samaada meluluskan ataupun tidak.

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LIST OF ACRONYMS

HLES	Housing Loan Evaluation System
IDE	Integrated Development Environment
ANN	Artificial Neural Network
AI	Artificial Intelligence
BLR	Base Lending Rate
MRTT	Mortgage Reducing Term Takaful
MRTA	Mortgage Reducing Term Assurance
MLTA	Mortgage Level Term Assurance
CCRIS	Central Credit Reference Information System
CTOS	Credit Tip Off Service Sdn. Bhd
DSR	Debt Salary Ratio
BLR	Base Lending Rate
UMP	Universiti Malaysia Pahang
UML	Unified Modelling Language
RUP	Rational Unified Process
POI	Programming
RAM	Random Access Memory
API	Application Programming Interface

CHAPTER 1

INTRODUCTION

1.1 Introduction

Nowadays, billions of Malaysians are engaged to at least one housing loan contract when they buy their own houses, and thousands are still applying. A lot of work has to be done by the loan companies (banks) in order to determine the affordability, and possibilities of payment.

There are many housing loan companies (banks) which provide different type of loans with different type of factors .The use of artificial intelligent integrated system is widely known nowadays as it helps to lessen human burden with its effectiveness in making analysis and prediction using all those factors. Of all the artificial intelligence technique, the Artificial Neural Network fits the best technique to do forecast.

Most of the time, a housing loan company (bank) will have to face a lot of applications for a loan, and each of this application needs to be reviewed thoroughly before approving. Factors have to be taken into consideration, calculated and come out with a prediction whether the customer are afford to pay recurrently the loan they chose.

The HOUSING LOAN EVALUATION SYSTEM is developed to help the loaner (banks) in predicting their customer's affordability in payment and making decision. Thus, this system can maximize the profits for the company through avoiding losses in the future.

1.2 Problem Statement

Normally, the housing loan companies have to do the same calculations for all of their customers' loan applications. This manual system is tiring and time consuming.

Apart from that, the process of approving a housing loan is done by human using logical reasoning and a few surface calculations. This method does not involve every factor that is related, and some major ones may be overlooked. The result obtained from this way is not accurate to make close predictions about the ability of the customers in making payments in the future.

Different housing loan companies (banks) have different criteria/factors they need. These factors bear different weightages and some of them may not even affect the customers' ability to pay at all.

1.3 Project Objective

In order to develop the Housing Loan Evaluation System, the overall objectives of this system are:

i. To develop the prototype of Housing Loan Evaluation System

ii. To produce the most accurate evaluation about the customers' potential in paying.

iii. To sort between the major and minor factors.

1.4 Scope

The project scopes that have been identified are divided into 3 types which are user module, data and system environment. The user of this system will be the housing loan agent (banks). The requirements are taken from 3 housing loan providers (banks) which are Maybank, Bank Islam, and CIMB Bank, and the data is gathered from questionnaire surveyed from government officials which includes administration staffs, support staffs, and professional staffs. The system covers the calculation of the loan. This system use standalone application concept and will be developed using NetBeans IDE 6.9.1 for the interfaces and Java for the programming languages.

1.5 Thesis Organisation

This thesis is divided into 6 chapters and each chapter is devoted to discuss different issue in the project. Chapter 1 will discuss on introduction to the system. The problem statement, objective and scope will be identified. Chapter 2 will discuss about all the research and literature review that related to the project. Chapter 3 will discuss the approach and framework for the project. It explains about the method that is implemented while designing the system. Justification about hardware and software that used to develop the system will also be discussed. Chapter 4 will document all processes that involve in the development of this project, generally, this chapter explains about the designed project development. Chapter 5 will discuss about the results and data analysis that had been acquired. The result included result analysis, project limitation and suggestions for project enhancement. Chapter 6 will briefly summarize the overall developed project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this section, it will be devoted to discuss on the housing loan evaluation by neural network, comparison of the current application and the explanation of the technique that is used for this application. All the information of the housing loan evaluation is retrieved from the combined sources of books, interview, and internet.

2.2 Domain

In terms of literature review, loan is an arrangement which a lender gives money or property to a borrower, and agrees to return the property or repay the money, usually along with interests, at some future point(s) in time. Usually, there is a pre-determined time for repaying a loan, and generally the lender has to bear the risk that the borrower may not repay a loan (through modern capital markets have developed many ways of managing this risk). Neural network is a mathematical model or computational model that is inspired by the structure and/or functional aspects of biological neural networks. It consists of an interconnected group of artificial neurons and processes information using a connectionist approach to computation. In most cases, an ANN is an adaptive system that changes its structure based on external or internal information that flows through the network during the learning phase. Modern neural networks are non-linear statistical data modelling tools. They are usually used to model complex relationships between inputs and

outputs. Next, the interest rate is the percentage charged or paid, for the use of money. It is charged when the money is being borrowed, and paid when it is being loaned.

The Housing Loan Evaluation System works by using the inputs to train itself to become more accurate in its processes. The weightage of factors will keep being updated as many inputs are taken into process, thus gaining a high accuracy algorithm to do the evaluation from time to time. The system flow consists of 3 parts; Input Loan and Customer Details, Loan Calculation (Neural Network Backward Propagation), and Output Report. In the input loan and customer details section, user will be prompted to key in the factors such as the loan duration, interest rates, salary and liabilities. Next, the system will go to the Loan Calculation system, where all the factors will be inserted into the network, calculated through 20 hidden layers, updating weights of hidden layers and output layer, sigmoid function calculation, and finally generate output as the outcome. Lastly, user can see the Output Report section which will display the output of the calculations, which later can be compared with the actual outcome of the respective set of data.

Inside every section of the system, operations and processes will be done which is invincible to the eyes of the user. The system will do a calculation upon both inputs from Loan and Customer Details. As these inputs are in the form of thousands and billions ringgit, they will first be represented by smaller figures before further calculations using data normalisation, which produces data within the range of 0 to 1. A proper factor will be divided to every input to get those smaller figures. These inputs and their respective weights will then be calculated before going to the summing function, which total up all the weighted factors. They will go through the activation function, which controls the amplitude of the output. The activation values of all layers will then be inserted into sigmoid function, and if the summation will be deducted with threshold values. The result of this is the output, and the range of output will be from 0(reject) or 1(accept).

In the end, the user will get a positive real number which shows the strength of the customers' ability to pay. The real number will be from 0 to 1 and the user will make his/her decision based on the output levels; strongly reject (0.00 – 0.25), fairly reject (0.26 – 0.50), fairly accept (0.51 – 0.75), and strongly accept (0.76 – 1.00). There are a few system that has been developed which turn to research to help understanding in terms if expert system concept, artificial neural network, the weakness and the way to implement it in this system. This research encircles system

that has been developed by local developer or international.

2.2.1 5 ways to increase to your home loan eligibility

Home loan interest rates have inched up in the last few months. This in turn, has affected the loan eligibility for home loan borrowers. Home Loan eligibility is inversely related to rates. As interest rates rise, loan eligibility becomes stiffer. In such a scenario, some home loan borrowers might have to re-evaluate their options (in terms of loan amount) on account of the new eligibility criteria. Here is presented 5 ways by which individuals can enhance their home loan eligibility.

i. Increasing the loan tenure

One very elementary method of enhancing the home loan eligibility is by opting for a higher tenure. This is so because the EMI (Equated Monthly Instalment) per lakh, which an individual has to pay, starts to decline as the tenure increases. The reason being that other factors like interest rate as well as the principal amount remain the same, despite the higher tenure. What changes though, is the net interest outgo, which rises with a rise in tenure. And since the individual is paying a lower EMI now, his 'ability to pay' and therefore his loan eligibility, automatically increase.

ii. Repaying other outstanding loans

Individuals with outstanding loans like car loans or personal loans may face a problem with loan eligibility; the same might adversely affect their home loan eligibility. Industry standards suggest that existing loans with over 12 unpaid instalments are taken into account while computing the home loan borrower's eligibility. In such a scenario, individuals have the option of prepaying in part/full their existing loans. This will ensure that their eligibility for the home loan purpose is unaffected.

For example, if the home loan seeker has an outstanding personal loan, where 16 EMIs remain to be paid, then he can prepay the same and approach the HFC with a clean slate. Alternately, he also has the option of prepaying 5 EMIs thereby ensuring that the existing loan liability doesn't impact his eligibility for the home loan.

iii. Clubbing of incomes

Another way of increasing loan eligibility is by way of clubbing incomes of spouse/father/mother/son. An illustration will help in

understanding things better. Suppose an individual's loan eligibility, based on his income, works out to approximately Rs 1,000,000 for a given set of criteria. But the individual wants a loan worth Rs 2,000,000. Assume that this individual's spouse too is earning a similar annual income. In such a case, the individual can club his spouse's income alongwith his own income and then opt for a home loan. The eligibility in this case, will be calculated on the clubbed income of both husband and wife- thereby enhancing the individual's eligibility to the extent of the spouse's income. In our example, the eligibility will now stand doubled at Rs 2,000,000 from Rs 1,000,000 earlier.

iv. Step-up loan

Individuals can also opt for step-up loans and enhance their loan eligibility. Simply put, a step-up loan is a loan wherein an individual pays a lower EMI during the initial years and the same is enhanced during the rest of the loan tenure. For example, a Rs 1,000,000 home loan at 7.5% for a 20-Yr tenure would imply paying an EMI of Rs 6,760 the first 2 years and Rs 8,340 for the remaining tenure. HFCs usually consider the lower EMI of the initial years to calculate his loaneligibility. The initial lower EMI helps increase the individual's 'capacity to borrow'.

v. Perks

Salaried individuals must ensure that variable sources of income like performance-linked pay among others are taken into consideration while computing their income. This in turn will imply that the loan amounts they are eligible for, stand enhanced as well.

As can be seen, there are many ways to increase loan eligibility. However, individuals need to keep in mind that increasing the eligibility can have an impact on their financial planning. For example, if an individual decides to prepay an existing personal loan for the sake of becoming eligible for a higher loan amount, he might be faced with a cash crunch. Hence a detailed scrutiny of one's financial standing is warranted before opting for an inflated home loan.

The examples in this note should only be treated as illustrations. Individuals need to work out solutions best suited for their profile after speaking to their home loan consultant and only then consider acting on the options discussed.

2.2.2 FNB HOME LOAN NEWS

The dramatic rise in the value of residential property in recent times is changing the face of South Africa's housing market.

Values have in some instances gone up three-fold in just two years. "Phenomenal growth in property value has boosted residential development in the country," says First National Bank (FNB) Housing Finance CEO, Marius Marais.

According to Marais, even if the rapid rise in property prices eases, there are other growth markets. "The positive sentiment towards property is also extending into properties that were overlooked in the past – principally houses in townships," he explains.

"For the first time township properties have become assets to their owners and a healthy sales environment is emerging. It is an arena in which FNB will expand its role of providing finance and helping to reduce the housing backlog."

He continues: "With the residential housing market being highly finance-dependant, creating more flexible lending conditions in all areas is a key issue that will notably increase accessibility to housing."

Despite the government's significant achievement in the delivery of over 1.6 million houses in the 10 years since 1994, there is still a sizeable housing backlog in the country.

As part of on-going efforts to address the problem, on 31 March 2005, the Minister of Housing and the country's four major banks signed a Memorandum of Understanding in which all parties committed to creating functioning housing markets in previously under-served areas, and to making home loan finance available and accessible to low-income customers. This agreement emanates from the Financial Sector Charter signed in 2003.

Different approaches and interventions have been applied to address the lack of adequate housing in the country, and as part of its commitment to these efforts,

FNB has diversified its product portfolio to include a home loan called SmartBond. The offering aims to be inclusive by also serving the target market as defined by the Financial Sector Charter. SmartBond is designed for people earning a single or joint gross monthly income of between R2 500 and R10 000.

Over and above easy access to a home loan, other key distinguishing SmartBond features include:

i. A 5-year fixed rate resulting in fixed monthly instalments
ii. Affordable life insurance with no medical check required
iii. Full loan amount plus bond costs

"FNB believes that broadening access to credit will not only increase the quality of life for ordinary South Africans, but also create tremendous opportunities for residential development – boosting the country's urban housing scene by enabling the development of properly planned and quality suburbs," says Marais.

"Through owning property, more people will be able to grow their personal wealth. Property ownership is virtually a risk-free investment, so it's a secure form of saving." "Wealth creation for a broader base of South Africans is vital for the growth of the economy," Marais concludes.

2.3 Recent Works

2.3.1 Soft Computing Approach for Bond Rating Prediction

2.3.1.1 Introduction

Soft computing is popularly referred to as a collection of methodologies that work synergistically and provide flexible information processing capabilities for handling real-life situations. Its aim is to exploit the tolerance for imprecision, uncertainty, and approximate reasoning in order to achieve tractability and robustness. Currently, fuzzy logic (Wang, 1997), artificial neural networks (Mehtora, 1997; Hassoun, 1995), and genetic algorithms (Deb, 2001) are three main components of soft computing. ANN is suitable for building architectures for adaptive learning, and GA can be used for search and optimisation. Fuzzy Logic provides methods for dealing with imprecision and uncertainty. The analytic value of each one of these tools depends on the application.

Neural netowrks learn from experience, especially used in pattern recognition (Mehtora, 1997; Hassoun, 1995). This distinguishes neural networks from traditional computing programs, which simply follow instructions in a fixed sequential order. Fuzzy inference systems (Wang, 1997) are useful for situations where human expertise (that cannot be translated into a set of equations) needs to be incorporated into a decision-making, automated process (e.g power plant control). Evolutionary programming, evolutionary strategies and genetic algorithms (Wang, 1997) are useful for optimisation problems where their particular difference is in how they avoid local extrema (i.e error minimization for parameter estimation).

It is defined that term high dimensional problems as those problems which have a relatively greater number of input variables.

Proposition 1: A problem with n input variables is said to be an n-dimensional problem.

In this chapter, a soft computing technique is used to handle high dimensional problems. We have taken an example of bond rating prediction problem (Sehgal,