

## Neural Network Modeling for an Intelligent Recommendation System Supporting SRM for Universities in Thailand

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### **Abstract**

*In order to support the academic management processes, many universities in Thailand have developed innovative information systems and services with an aim to enhance efficiency and student relationship. Some of these initiatives are in the form of a Student Recommendation System (SRM). However, the success or appropriateness of such system depends on the expertise and knowledge of the counselor. This paper describes the development of a proposed Intelligent Recommendation System (IRS) framework and experimental results. The proposed system is based on an investigation of the possible correlations between the students' historic records and final results. Neural Network techniques have been used with an aim to find the structures and relationships within the data, and the final Grade Point Averages of freshmen in a number of courses are the subjects of interest. This information will help the counselors in recommending the appropriate courses for students thereby increasing their chances of success.*

**Keywords:** *Intelligent Recommendation System; Student Relationship Management; data mining; neural network*

### **1 Introduction**

The growing complexity of technology in educational institutions creates opportunities for substantial improvements for management and information systems. Many designs and techniques have allowed for better results in analysis and recommendations. With this in mind, universities in Thailand are working hard to improve the quality of education and many institutes are focusing on how to increase the student retention rates and the number of completions. In addition, a university's performance is also increasingly being used to measure its ranking and reputation [1]. One form of service which is normally provided by all universities is Student Counseling. Archer and Cooper [2] stated that the provision of counseling services is an important

factor contributing to students' academic success. In addition, Urata and Takano [3] stated that the essence of student counseling should include advices on career guidance, identification of learning strategies, handling of inter-personal relation, along with self-understanding of the mind and body. It can be said that a key aspect of student services is to provide course guidance as this will assist the students in their course selection and future university experience.

On the other hand, many students have chosen particular courses of study just because of perceived job opportunities, peer pressure and parental advice. Issues may arise if a student is not interested in the course, or if the course or career is not suitably

matched with the student's capability [4]. In Thailand's tertiary education sector, teaching staff may have insufficient time to counsel the students due to high workload and there are inadequate tools to support them. Hence, it is desirable that some forms of intelligent recommendation tools could be developed to assist staff and students in the enrolment process. This forms the motivation of this research.

One of the initiatives designed to help students and staff is the Student Recommendation System. Such system could be used to provide course advice and counseling for freshmen in order to achieve a better match between the student's ability and success in course completion. In the case of Thai universities, this service is normally provided by counselors or advisors who have many years of experience within the organisation. However, with increasing number of students and expanded number of choices, the workload on the advisors is becoming too much to handle. It becomes apparent that some forms of intelligent system will be useful in assisting the advisors.

In this paper, a proposed intelligent recommendation system is reported. This paper is structured as follows. Section 2 describes literature reviews of Student Relationship Management (SRM) in universities and issues faced by Thai university students. Section 3 describes Neural Network techniques which are used in the reported Intelligent Recommendation System, and Section 4 focuses on the proposed framework, which presents the main idea and the research methodology. Section 5 describes the experiments and the results. This paper then concludes with discussions on the work to be undertaken and future development.

## 2 Literature Review

### A. Student Relationship Management in Universities

According to literature, the problem of low student retention in higher education could be attributed to low student satisfaction, student transfers and drop-outs [5]. This issue leads to a reduction in the number of enrolments and revenue, and increasing cost of replacement. On the other hand, it was found that the quality and convenience of support services are other factors that influence students to change educational institutes [6]. Consequently, the concept of SRM has been implemented in various universities so as to assist the improvement of the quality of learning processes and student activities.

Definitions of SRM have been adopted from the established practices of Customer Relationship Management (CRM) which focuses on customers and are aimed to establish effective competition and new strategies in order to improve the performance of a firm [7]. In the case of SRM, the context is within the education sector. Although there have been many research focused on CRM, few research studies have concentrated on SRM. In addition, the technological supports are inadequate to sustain SRM in universities. For instance, a SRM system's architecture has been proposed so as to support the SRM concepts and techniques that assist the university's Business Intelligent System [8]. This project provided a tool to aid the tertiary students in their decision-making process. The SRM strategy also provided the institution with SRM practices, including the planned activities to be developed for the students, as well other relevant participants. However, the study verified that the technological support to the SRM concepts and practices were insufficient at the time of writing [8].

In the context of educational institutes, the students may be considered having a role as "customers", and the objective of Student Relationship Management is to increase their satisfaction and loyalty for the benefits of the institute. SRM may be defined under a similar view as CRM and aims at developing and maintaining a close relationship between the institute and the students by supporting the management processes and monitoring the students' academic activities and behaviors. Piedade and Santos (2008) explained that SRM involves the identification of performance indicators and behavioral patterns that characterize the students and the different situations under which the students are supervised. In addition, the concept of SRM is "understood as a process based on the student acquired knowledge, whose main purpose is to keep a close and effective students institution relationship through the closely monitoring of their academic activities along their academic path" [9]. Hence, it can be said that SRM can be utilised as an important means to support and enhance a student's satisfaction. Since understanding the needs of the students is essential for their satisfaction, it is necessary to prepare strategies in both teaching and related services to support Student Relationship Management. This paper therefore proposes an innovative information system to assist students in universities in order to support the SRM concept.

### B. Issues Faced By Thai University Students

Another study at Dhurakij Pundit University, Thailand looked at the relationship between learning behaviour and low academic achievement (below 2.0 GPA) of the first year students in the regular four-year undergraduate degree programs. The results indicated that students who had low academic achievement had a moderate score in every aspect of learning behaviour. On average, the students scored highest in class attendance, followed by the attempt to spend more time on study after obtaining low examination grades. Some of the problems and difficulties that mostly affected students' low academic achievement were the students' lack of understanding of the subject and lack of motivation and enthusiasm to learn [10].

Moreover, some other studies had focused on issues relating to students' backgrounds prior to their enrolment, which may have effects on the progress of the students' studies. For example, a research group from the Department of Education[11], Thailand studied the backgrounds of 289,007 Grade twelve students which may have affected their academic achievements. The study showed that the factors which could have effects on the academic achievement of the students may be attributed to personal information such as gender and interests, parental factors such as their jobs and qualifications, and information on the schools such as their sizes, types and ranking.

Therefore, in the recruitment and enrolment of students in higher education, it is necessary to meet the student's needs and to match their capability with the course of their choice. The students' backgrounds may also have a part to play in the matching process. Understanding the student's needs will implicitly enhance the student's learning experience and increase their chances of success, and thereby reduce the wastage of resources due to dropouts, and change of programs. These factors are therefore taken into consideration in the proposed recommendation system in this study.

### 3 Neural Network Based Intelligent Recommendation System to Support SRM

In term of education systems, Ackerman and Schibrowsky [12] have applied the concept of business relationships and proposed the business relationship marketing framework. The framework provided a different view on retention strategies and an economic justification on the need for

implementing retention programs. The prominent result is the improvement of graduation rates by 65% by simply retaining one additional student out of every ten. The researcher added that this framework is appropriate both on the issues of places on quality of services. Although some problems could not be solved directly, it is recognized that Information and Communication Technologies (ICT) can be used and contributes towards maintaining a stronger relationship with students in the educational systems [8].

In this study, a new intelligent Recommendation System is proposed to support universities students in Thailand. This System is a hybrid system which is based by Neural Network and Data Mining techniques; however, this paper only focuses on the aspect of Neural Network (NN) techniques.

With respect to the Neural Network algorithm that was used in this study, the feed-forward neural network, also called Multilayer Perceptron was used. In the training of a Multilayer perceptron, back propagation learning algorithm (BP) was used to perform the supervised learning process [13]. The feed-forward calculations which use in this experiment, the activations set to the values of the encoded input fields in Input Neurons. The activation of each neuron in a hidden or output layer is calculated and shown as follows:

$$b_i = \sigma \left( \sum_j \omega_{ij} P_j \right) \quad (1)$$

where  $b_i$  is the activation of neuron  $i$ ,  $j$  is the set of neurons in the preceding layer,  $\omega_{ij}$  is the weight of the connection between neuron  $i$  and neuron  $j$ ,  $P_j$  is the output of neuron  $j$ , and  $\sigma ( m )$  is the sigmoid or logistic transfer function, which show as follows

$$\sigma(m) = 1/(1+e^{-m}) \quad (2)$$

The implementation of back propagation learning updates the network weights and biases in the direction in which the system performance increases most rapidly.

This study used a feed-forward network architecture and the Mean Absolute Error (MAE) to define the accuracy of the models.

#### 4 The Proposed Framework

Several solutions have been proposed to support SRM in the universities; however, not many systems in Thailand have focused on recommendation systems using historic records from graduated students. A recommendation system could apply statistical, artificial intelligence and data mining techniques by making appropriate recommendation for the students. Figure 1 illustrates the proposed recommendation system architecture. This proposal aims to analyse student background such as the high school where the student studied previously, school results and student performance in terms of GPA's from the university's database. The result can then be used to match the profiles of the new students. In this way, the recommendation system is designed to provide suggestions on the most appropriate courses

and subjects for the students, based on historical records from the university's database.

##### A. Data-Preprocessing

Initially, data on the student records are collected from the university enterprise database. The data is then re-formatted in the stage of data transformation in order to prepare for processing by subsequent algorithms. In the data cleaning process, the parameters used in the data analysis are identified and the missing data are either eliminated or filled with null values [15]. Preparation of analytical variables is done in the data transformation step or being completed in a separate process. Integrity of the data is checked by validating the data

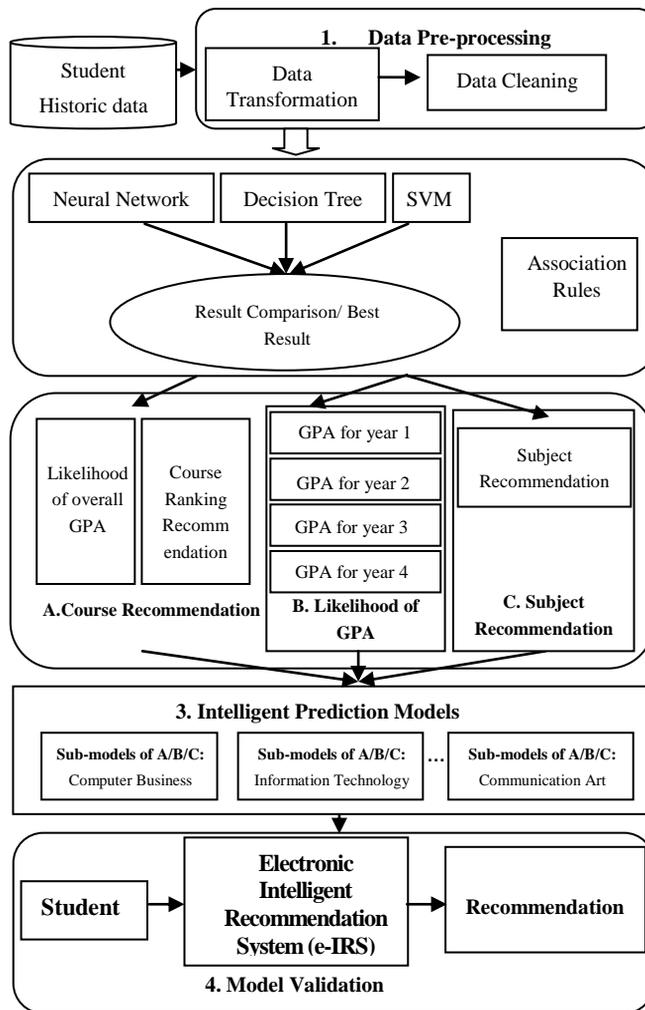


Figure 1: Proposed Hybrid Recommendation System Framework to Support Student Relationship Management

against the legitimate range of values and data types. Finally, the data is separated randomly into training and testing data for processing by the Neural Network.

### B. Data Analysis

It can be seen in Figure 1 that the Association rules, Decision Tree, Support Vector Machines and Neural Network are used to train the input data; however, this paper focuses on Neural Network which uses the feed-forward algorithm to classify the data and to establish the approximate function. The backpropagation algorithm is a multilayer network, it uses log-sigmoid as the transfer function, *logsig*. In the training process, the backpropagation training functions in the feed-forward networks is used to predict the output based on the input data.

### C. Intelligent Recommendation Model

The Integrated Recommendation Model is composed of three parts: Course Recommendation for freshmen, Likelihood of GPA for students (years 1 to 4), and Subject Recommendation for students (year 1 to 4) respectively.

Part A focuses on the course recommendation for freshmen and it is composed of two sections, which are the Overall GPA Recommendation, and the Course Ranking Recommendation respectively. In the section of Overall GPA, The output of this recommendation is in terms of an expected overall GPA. The outputs of Course Ranking Recommendation use the ranking of results in first section to indicate five appropriate courses

The results of both parts can be used as suggestions to the freshmen during the enrolment process. Some example results from Part A are shown in this paper, and the input data of these 2 sections in the model are shown in Table 1.

Another part of the framework focuses on Likelihood of GPA for students in each year. After the students selected the course to study and completed the enrolment process, the Likelihood of GPA for year 1 results can be used to monitor the performance of this group of students. The input data of this process is the same as the one shown in Table 1, with the addition of the GPA scores from the previous year. These are used as the extended features in the input to the neural network model. The result of the Recommendation is the GPA score of the year. In the same way, the system may be used to perform a

Likelihood of GPA for Year 2 based on results from the first year. Similar approach can be adopted for the Likelihood of Year 3 and 4 results. Some example results of this part are shown in this paper.

The final part of the recommendation model focuses on the subject recommendation for students in each year. This way also can help the counselor or student's supervisor recommend student to enroll the subjects in each semester.

To address the issue of imbalanced number of students in each course, the prediction model shown in Figure 1 can be duplicated for different departments. The models' computation is entirely data-driven and not based on subjective opinion, hence, the prediction models are unbiased and they will be used as an integral part of an Electronic Intelligent Recommendation System.

### D. Electronic Intelligent Recommendation System (e-IRS)

It is planned that the new intelligent Recommendation Models will form an integral part of an online system for private universities in Thailand. The developed system will be evaluated by the university management and feedback from experienced counselors will be sought. The proposed system will also be available for use by new students who will access the online-application in their course selection during the enrolment process. As for the recommendation of the Year 2 and subsequent years' results, this could be used by the counselors, staff, student's supervisor and university management to provide supports for students who are likely to need help with their studies. This information will enable the university to better focus on the utilisation of their resources. In particular, this could be used to improve the retention rate by providing additional supports to the group of students who may be at risk.

## 5 Experiment Design

The data preparation and selection process involves a dataset of 3,550 student records from five academic years. All the student data have included records from the first year to graduation. Due to privacy issue, the data in this study do not indicate any personal information, and no student is identified in the research. The student data has been randomised, and all private information has been removed. Example data from the dataset is shown below.

**Table 1:** Example of Training Sample Dataset

Uni ID	Input data: previous school data								target
	Pre-GPA	Type of school	No. of Awards	Talent and Interest	Channels	Admission Round	Guardian Occupation	Gender	Uni GPA
4800	2.35	C	0.2	1	Poster	1	Police	F	3.75
4801	3.55	B	0.3	4	Brochure	2	Governor	M	3.05
5001	2.55	A	0.9	3	Friend	5	Teacher	F	2.09
5002	2.75	G	0.4	5	Family	4	Nurse	F	2.58
5003	3.00	F	0.2	7	Newspaper	3	Teacher	M	2.77
5101	2.00	E	0.1	2	others	1	Farmer	F	2.11

**Table 2:** Definitions of Variables

No.	Variables	Definition
1.	UniID	Randomized Student ID which is not included in the clustering process. They are only used as an identification of different students
2.	GPA	Overall GPA results from previous study prior to admission to university
3.	Type of school	The school types are separated as follows A: High School B: Technical College C: Commercial College D: Open School E: Sports, Thai Dancing, Religion or Handcraft Training Schools F: Other Universities (change universities or courses) G: Vocation Training Schools
4.	Number of Awards	Awards that students have received from previous study (normalized between 0.0 to 4.0, 0.0 – received no award, 4.0 – received max no. of awards in the dataset)
5.	Talent and Interest (in Group number)	Talent and the interest (1= sports, 2=music and entertainment, 3= presentation, 4=academic, 5=others, 6= involved with 2 to 3 items of talents and interests, 7= involved with more than 3 talents and interests)
6	Channels	The channels to know the university such as television, family
7	Admission Round	Admission round of each university which can be round 1 to 5
8	Guardian Occupation	The occupation of Guardian such as teacher, governor
9.	Gender	Gender: Female or Male
10.	Uni GPA	Overall GPA in university which the range is from 0 to 4

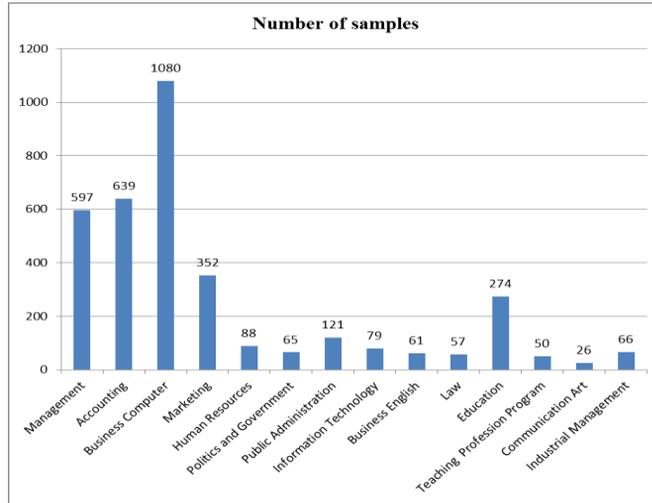


Figure 2: Number of samples in each department

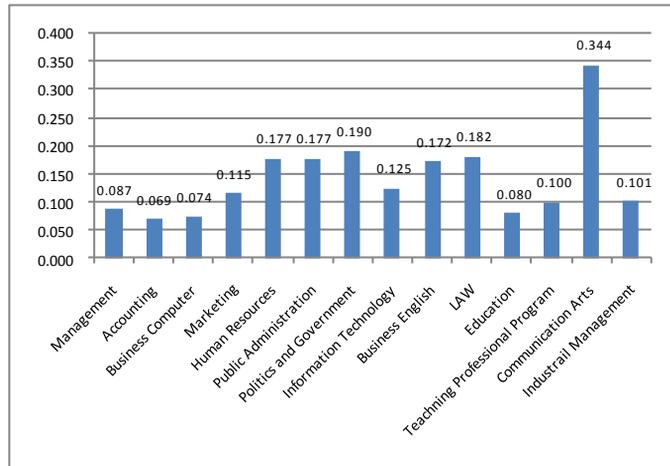


Figure 3: Comparison of MAE of testing data of sub-models for overall GPA and course ranking Recommendation

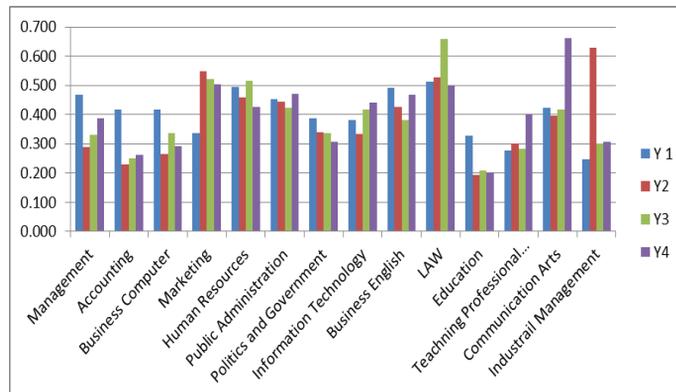


Figure 4: Comparison of MAE of testing data on the Likelihood of GPA in each Year

Table 1 shows the randomized student ID, GPA from previous study, the type of school, awards received, talent and interest, channels to know the university, admission round, Guardian Occupation, Gender and Overall GPA from university. Table 2 provides the definitions for the variables used in the above table.

The student records have been divided into 70% of training data and 30% of testing data randomly. The dataset includes both qualitative and quantitative information in Table 1 and 2. In terms of training, this study used a two layer feed forward network architecture. Moreover, this study used the Mean Absolute Errors (MAE) to define the accuracy of the models.

## 6 Experimental Results

Based on MAE, the experimental results have shown that the Neural Network based models can be utilised to predict the GPA results of students with a good degree of accuracy.

The testing was carried out in the final step of the experiment in each model, which used 30% of the available data. In Figure 3, it is shown that the lowest value of Mean Absolute Error (MAE) is 0.069 based on data from the Department of Accounting. On the other hand, the highest value is 0.344. The average of MAE of all models is 0.142. The overall results obtained indicated reasonable prediction results were obtained.

Figure 4 shows a comparison of MAE of the results of the sub-models from each department in each year. It can be seen that the range of values of MAE is the lowest based on data from the Department of Education. On the other hand, the highest value is based on the Department of Communication Arts, which is similar with the results of overall GPA. The average of MAE of all models is 0.393. Considering, the department of Public Administration gives the similar results between each year, while the department of Communication Art and the department of Industrial Management give the most different results between each year, which the results of MAE is too high from another in year 4 and year 2 respectively. It's possible that the difference of MAE is due to the number of training and testing data. The overall results obtained have indicated reasonable recommendation results.

## 7 Conclusions

This article describes a recommendation system in support of SRM and to address issues related to the problem of course advice or counseling for university students in Thailand. The recent work is focusing on the development and implementation of each process in the framework. The experiments have been based on Neural Network models and the accuracy of the recommendation model is reasonable. It is expected that the recommendation system will provide a useful service for the university management, course counselors, academic staff and students. The proposed system will also support Student Relationship Management strategies among the Thai private universities.

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