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Decision Support and Data Mining for Direct Consumer-to-consumer Trading

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Abstract— **This paper describes a decision support system that integrates a hybrid neighborhood search algorithm for determining the price of sale item when it is placed for trading in the Internet. The seller would provide the condition and number of years of usage of the used item, and the intelligent system would provide real-time search on related items in the marketplace and suggest a price for trading. Data mining techniques are explored for efficient processing of a vast amount of information in the database tables. In addition, the trading system would also have the intelligence of recommending items or products to a potential buyer given the previous purchase patterns. Related items to a recently purchased item would also be suggested with an aim of providing friendly reminders and recommendations so that the user of the website would obtain a pleasant trading experience.**

Keywords— used goods; data mining; artificial neural network; decision making; online trading; e-Commerce

I. INTRODUCTION

The rapid development of information technology has facilitated an elegant trading environment in the Internet. There are many trading platforms nowadays but there is no good platform designed for direct consumer-to-consumer trading primarily for university students, to buy and sell their goods and services directly to other students within their university or city. Such a need arises in a social network where items should be traded or exchanged easily with a small community. The famous websites such as Amazon or eBay are too global in nature and does not support the direct trading of goods and services among the students in a small social network such as a campus environment.

The contribution of this paper is on a decision support system embedded with a hybrid neighborhood search algorithm, with emphasis on solving a price-recommendation problem in a real-world internet trading platform. The platform is targeted for direct consumer-to-consumer trading among university students. An online web application has been developed and items for trading include books, household items, electronics, housing rental, sports equipment and tutoring services. The web application design needs to be modern, fast, and very simple to use. It is developed using PHP, the Laravel framework, HTML, CSS and MySQL. The solution to the price-recommendation problem would require techniques from decision-support systems as well as data-

mining on a database of used items already traded or currently available.

The paper is organized as follows. In Section 2, a review on online trading in the Internet is given. Section 3 introduces the architecture of the trading platform. A hybrid neighborhood search algorithm designed for tackling the current search and match issues in price recommendation is also described. In Section 4, a neural network for recommending a selling price is described. Section 5 would give the details on the current implementation. Finally, discussions and conclusions are given in Section 6 of the paper.

II. REVIEW ON ONLINE CUSTOMER-TO-CUSTOMER TRADING IN THE INTERNET

There are currently a few online marketplaces in the Internet that facilitate C2C trading, but they have various drawbacks. Specific examples of some online marketplaces include eBay [1], Gumtree [2], iswapbooks [3], theprintspace [4] and Sellingfree [5]. Below are the descriptions of the drawbacks of these websites.

A. eBay [1]

eBay is an example of a very large C2C web platform, processing transactions in the range of multi-billions of dollars. Customers from anywhere in the world can purchase items from a seller, anywhere. However the broadness and flexibility of eBay also introduces some problems. First, the account setup is complex. The seven-page sign up form also requires PayPal account information. A Paypal account is mandatory, which is linked to a bank account. The whole process is very time consuming and a lot of personal information is needed during account setup. Such a platform is not suitable for the trading of used items among university students in a local community. The students on campus or in the neighborhood region would not like to be bothered by the Paypal payment system or the mailing of the used item to the buyer, who is likely to be just another student on campus.

B. Gumtree [2] and iswapbooks [3]

Gumtree and iswapbooks are websites that host the advertisements only. The payment and item-mailing issues are all handled by the users/customers directly. This setup would eliminate the work required on handling payments. Yet, the homepage of Gumtree is cluttered and overly busy. All the

categories and subcategories are laid out, and hence there are too many words on the page. The 'Post an add' button is relatively obvious and clear, but it actually directs to a sign-up page. iswapbooks has a cleaner homepage, but the design of a book post places heavy emphasis on the cover image. However, most of the images are missing which makes the site look empty and under-used.

C. theprintspace [4]

Theprintspace is an online marketplace for photography equipment. It has a clean homepage that is easy to use. One would need to be a registered user to post an item, and there is the ability to log in with external accounts (Facebook, Google). A buyer can send a message to the seller through the website without logging in. The simple webpage design makes it easy to use.

D. Sellingfree [5]

Sellingfree is also an online marketplace for trading of products and services among the customers. No bank account or payment issues are involved in the user account setup. The website does not hold such information and the detailed trading is just between the seller and buyer. Yet, during the user registration, there is no verification process on the user. Also, there is no information on the location (city or region in a certain country) of the seller in the website. Such location information is very useful for a potential buyer would take that into consideration in the purchase. A buyer is more likely to purchase from his neighbourhood, for the shipment cost would be minimal or nil. Another drawback of the site is that the email address of the seller is released to whoever just browses at the item.

In summary, the large online marketplace sites have many drawbacks. If the targeted users are students or people within a local community, a new web application can be developed to make a typical transaction simpler, as it can be tailored to suit the lifestyle of students. In addition, artificial intelligence techniques can be incorporated so that the trading platform is more helpful and intelligent.

For a seller, an intelligent trading platform would provide real-time search on related items in the marketplace and suggest a price for the sale item. Techniques from data mining, decision-support system and neural network would contribute to the software development. For a buyer, given information on his previous purchased items or his interests, sale items can be recommended to him. The aim of this paper is to show the development of an intelligent, simple-to-use and user-friendly trading platform targeted for direct consumer-to-consumer trading among university students. It must be mentioned that a registered user can be easily verified as a university student by his/her university email address, which helps to provide a high degree of security for all registered users. This would facilitate easy trading of used goods/items among students within a local community or on campus.

III. ARCHITECTURE OF THE DECISION SUPPORT SYSTEM

The decision support system (DSS) aims to provide a flexible and interactive tool to help solve the price-

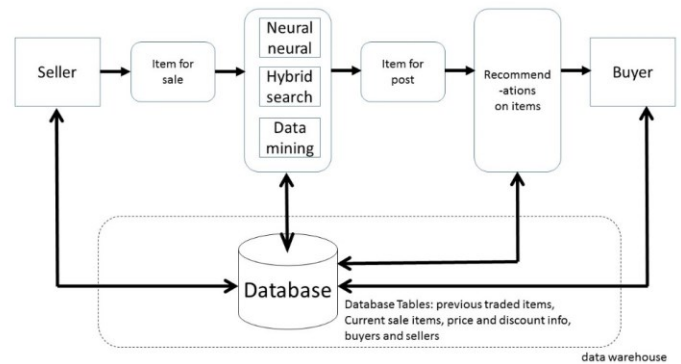recommendation problem. Figure 1 shows the architecture of the DSS.

Figure 1. Architecture of the decision support system.

Employing the methods of the information technology, the DSS is designed as a distributed intelligent system with a user-friendly interface. It is a graphical interface that facilities the seller's decision making process on determining a price for sale in the Internet marketplace. The information of related items in the database would be needed in the decision support process. Data mining on the vast amount of information is needed in order to provide real-time response to the seller. In this paper, a hybrid neighborhood search algorithm has been used.

It is necessary to develop a robust and fast algorithm to deal with an online user request for selling price recommendation. The price of the item if brand new has to be determined or provided by the seller. A reasonably detailed description of the item for sale, along with its used condition and number of years of usage would be needed. A hybrid neighborhood search algorithm [6, 7] is proposed here to tackle the online problem.
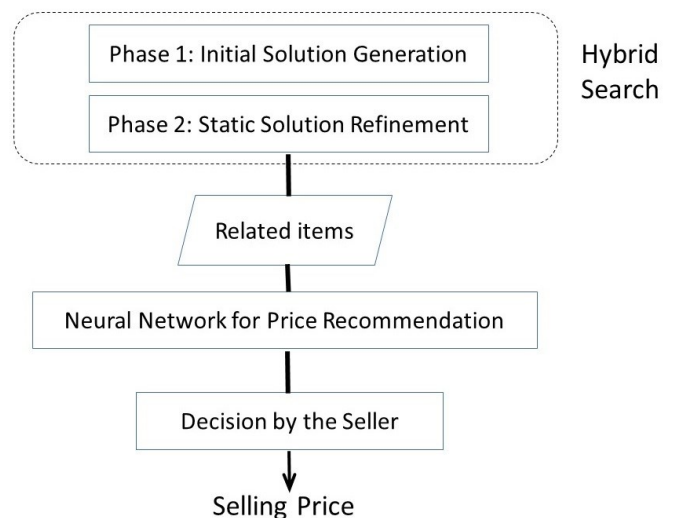

Figure 2. Hybrid search and price recommendation.

As shown in Figure 2, HNS contains two phases. In generating the initial solution, the item category would be automatically determined and a greedy look-ahead heuristic is

employed in the first phase to find some feasible solutions [6, 7]. As fast real-time response is important in the interface, the heuristic would generate the initial solutions for subsequent processing. The same algorithm has also been used very successfully in another decision support system [6].

Data mining [8] tasks can also be performed offline (previously) for the automatic analysis of large quantities of data related to the items for sale and previously traded. In this paper, the focus is on the discussion of the decision support system. Yet, data mining is also important in identifying multiple groups of data, which would then be used by the decision support system.

Phase two of the HNS is on static solution refinement. After the initial solution is derived from Phase 1, we use a neighborhood search algorithm called Variable Neighborhood Search (VNS) to improve on the initial solution. VNS is a meta-heuristic first proposed by Mladenovic´ and Hansen [9]. Its competitive performance in working out some combinatorial optimization problems lies in its systematic change of the neighborhood during the local search process. VNS has undergone progressive development and several extensions are proposed and applied in a wide range of fields like data mining and graphic problems. In particular, a collection of studies have shown that VNS outperforms other approximate search algorithms. In this paper, a hybrid neighborhood search based on the philosophy of VNS is used and embedded in the decision support system as a core computational engine. Details can be found in [6, 9].

IV. NEURAL NETWORK APPROACH FOR PRICE RECOMMENDATION

Artificial neural network (ANN) is based on intelligent computational model, and uses the computer network system to simulate the biological neural network. It consists of an input layer of source, at least one middle or hidden layer of computational neurons, and an output layer of computational neurons [10-12]. The ability of an ANN is to discover the nonlinear relationship between its inputs and outputs. It has played a major role in many scientific and industrial applications, such as time series prediction, pattern recognition, decision making, load forecasting, event prediction etc. [13-14]. In the current work, we aim to use a neural network to suggest on the price of the used item to be post for trading in the website. Figure 3 show the architecture of the ANN.
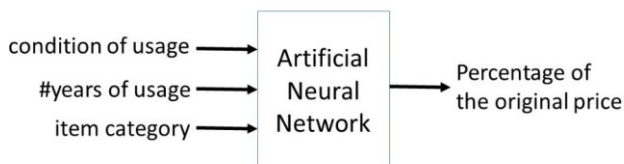
Figure 3. Structure of the artificial neural network.

The strength of a neural network is on its learning capability. It can solve the problem by first training the neural network using some training examples or instances of input-output pairs. The interconnection weights between the different layers in an ANN will be obtained at the end of the training.

The back-propagation (BP) neural network used in this paper is a typical architecture of multi-layered feed-forward neural network. It is probably the most popular type of ANN being used in many industrial applications and has been found to perform well on a wide variety of problems. A typical BP neural network is usually consisted of layers of neurons, and the objective is to train the network weights so as to minimize the mean-square error of the network output. It is widely recognized that the performance of the BP algorithm could be sensitive to the initial conditions. Hence, the training of the ANN is usually repeated a number of times so as to obtain a fair comparison of its performance.

V. IMPLEMENTATION OF THE INTELLIGENT TRADING PLATFORM

One important motivation for the current implementation is for university students within a small community or on campus, to buy or sell within the same community. Therefore, a registered user can submit an item post to his/her (university) community only. Registered buyers can also select to only view items being sold by those within the same community (university). Since all users within the same university community must be verified to be a student of that university, it is much easier for a seller to organize and complete a sale.

As an unregistered user, one of the limitations is that an item post can only be submitted publicly. Also, they can only view item listings within a city. Figure 4 shows the trading process of a seller and a buyer.
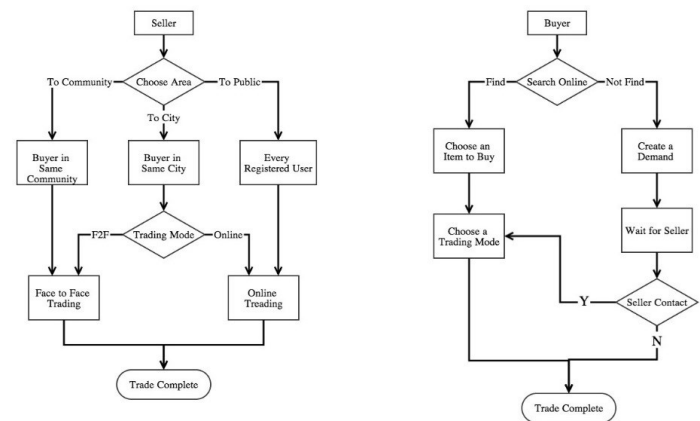
Figure 4. Trading process of a seller and a buyer.

Figures 5 to 8 show the GUI of the developed web application. It is developed using PHP, the Laravel framework, HTML, CSS and MySQL.
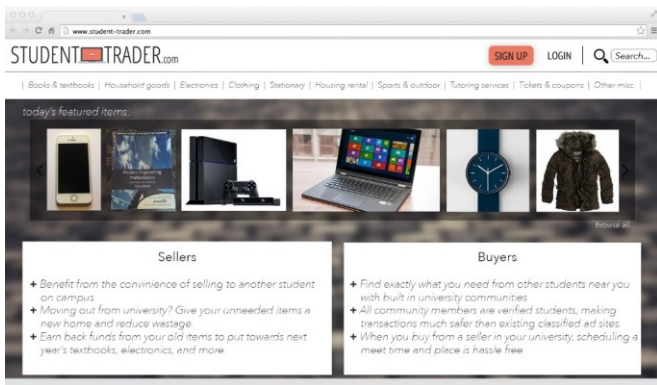
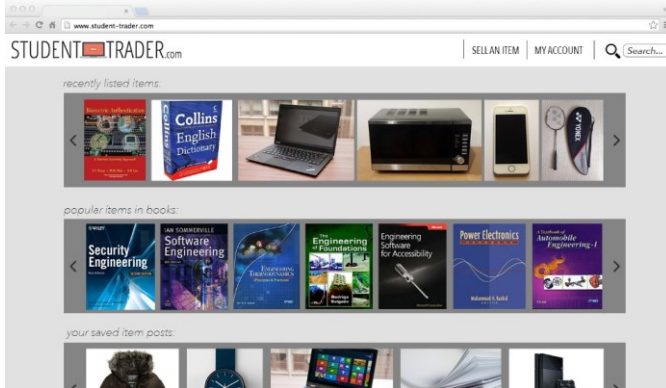Figure 5. The developed web application.

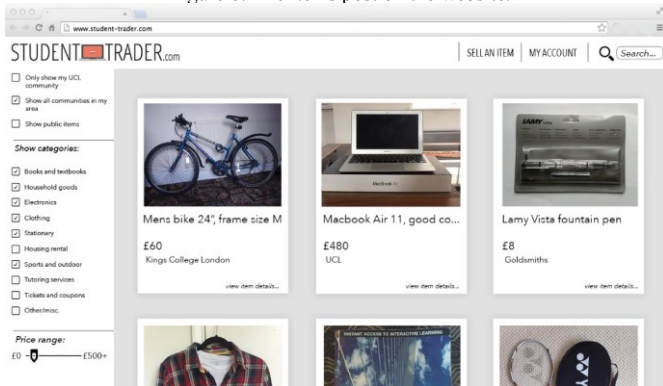Figure 6. The items post on the website.
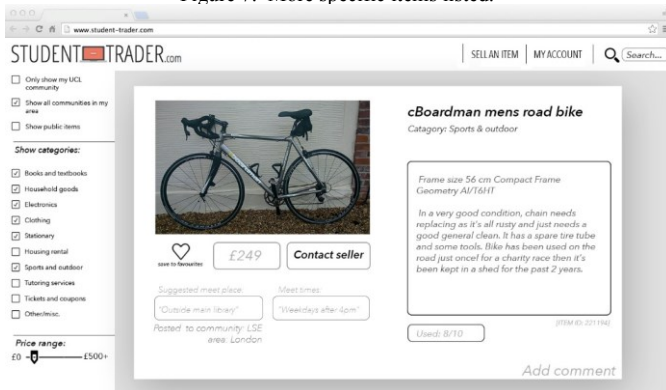

Figure 7. More specific items listed.

Figure 8. The GUI of the web application.

VI. DISCUSSIONS

There are currently many online trading platforms in the Internet. However, they have various drawbacks and are not welcome by university students who just want a simple and yet intelligent and user-friendly platform for trading on campus (or within a small community). For people trading within a small community, they would avoid any troubles to setup payment account or mailing of items to the buyer. This paper has been focused on the development of web application to facilitate such a need with an aim to providing an intelligent user-interface to both the sellers and the buyers.

VII. CONCLUSIONS

For a seller, the intelligent trading platform has provided real-time search on related items in the marketplace and would suggest a price for the sale item. This help a seller to post sale items in line with the market. Techniques from data mining, decision-support system and neural network have contributed to the process of software development.

For a buyer, the intelligent trading platform can gather information on his previous purchased items from the databases. Also, buyer can express his interests or post requests for certain desirable items. The system would then recommend sale items to the potential buyer. Overall, the platform targeted for direct consumer-to-consumer trading would be more intelligent, simpler-to-use and more user-friendly.

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