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A Last-Minute E-Auction for Hotel Rooms

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Abstract: Electronic auctions have rapidly become one of the most widespread applications in electronic commerce. Within e-auctions, the online products are almost anything imaginable such as electronic parts, artwork, vacation packages, airline tickets, etc. In this paper, the reverse auction was implemented by proposing a suitable bidding mechanism for perishable products like hotel rooms. These vacant rooms should be sold as soon as possible before their value zeroes. Therefore, the Last-Minute Auction not only helps the buyers get their desired rooms, but also helps the hotels to selling their rooms in time. The research combined the Hungarian algorithm and Branch-and-Bound search to match the buyers' demand and the sellers' supply and optimizing the auction site's revenue.

Keywords: Hospitality Business and the Internet, Reverse auction, Last-minute auction, Hotel room.

I. Introduction

An electronic auction (e-Auction) plays an important role in online business world today. With e-Auction, suppliers can sell their products at a price that meets buyers' expectations, saving time, reducing costs, increasing revenues and acquiring more benefits as well. On the other hand, consumers have chances to bargain, buying goods and services at affordable price anytime and anywhere.

Travel products such as air tickets, hotel rooms, and car rentals are last minute commodities with a limited lifetime. That is why the supplier should sell or rent them as early as possible to induce more revenues. How does a supplier make a dynamic decision to sell products early enough to maximize revenues? Even more important, how do consumers get hold of their desired product at the low price?

A reverse auction is beneficial for both parties. From the customer's perspective, it offers lower prices combined with a broader supplier base and a more efficient procurement process. Online buyers can save money when purchasing goods through the online auction because the very nature of an auction tends to force suppliers to reduce asking price progressively, in sync with demand.

However, reverse auctions are better suited to only particular kinds of product such as high-volume bulk commodities, while they tend to become less advantageous for goods that are more specialized. An auction can hardly handle such issues as complex product specifications, because the more complicated is the item description, the higher turns to be the risk.

This paper aims to apply the mechanism of a reverse auction for sales of a last-minute product, such as hotel rooms. In addition, the paper proposes an appropriate mechanism needed for the last-minute auction in accordance with the increasing role that reverse auction plays in an electronic business nowadays.

II. Background on E-Auction in Travel Industry

In travel industry, all major airlines, vacation services, travel agencies, car rental agencies, hotels, and tour companies provide online services. Auctions and bids are also conducted online permitting customers to bid for a ticket, a hotel room, or a rental car. There are many online auction sites in travel industry. Among the two major sites are following:

II.1 Lastminute.com

Brent Hoberman and Martha Lane Fox (<http://www.lastminute.com>) founded lastminute.com in 1998. It has become Europe's leading online travel retailer offering lifestyle products as well as travel-related services. Based on the idea of matching supply and demand, it offers consumers last minute opportunities to acquire airline tickets, hotel rooms, package holidays, entertainment tickets, restaurant reservations, home delivery, services, gifts and auctions. At lastminute.com, buyers bid for goods or services of a certain vendor who may be lastminute.com or a third party using three auction formats: English Auction, Reserve-Price Auction and Dutch Auction.

II.2 Priceline.com

Founded in 1998, Priceline.com is a reverse auction site where buyers select products they want to buy and the price they are willing to pay. The goods and services for sale or rent include airline tickets, hotel rooms, cars, packaged vacations and cruises. Priceline.com provides one auction format - sealed-bid first-price format. First, the potential buyer selects the city and the date that he or she wants to stay. Next, the buyer selects the specific areas and the quality level of a hotel. Then the buyer names the maximum price that he or she is willing to pay. When the system reviews the request, the buyer enters their credit card information. After that, Priceline.com searches its database for available hotel rooms and when a matching room with the price lower than the asking bid price is found, the bid is accepted, buyer's credit card is charged for their asking price with applicable taxes, and the buyer gets the room.

III. Proposed Last-Minute E-Auction

In the proposed Last-Minute auction, there are four major components: 1) Registration; 2) Room Request Posting; 3) Hotel Bidding; and 4) Demand and Supply Matching.

III.1 Registration Component

This component permits a customer to register as a member of the system. After the registration process, a customer obtains a login name and a password to log in the system.

III.2 Room Request Posting

This component permits a customer to post a hotel room request. A customer can request hotel rooms by specifying the city name, an area in the city, desired hotel star rating, number of rooms, and the maximum rate per night. To complete a request, a customer must provide credit card information.

III.3 Hotel Bidding

This component forwards room requests to participating hotels and invites them to place a bid. For bidding, each hotel must supply the number of vacant rooms and room rate per night. When there is a lower bid, the system will notify

hotels asking whether they want to reduce their bids.

III.4 Demand and Supply Matching

This component will match customers' need providing the supply of the hotels. The matching process starts with summarizing all requests, according to criteria - city name, area, hotel star rating and specified room rates. After that, system sends all requests to relevant hotels inviting them to place their bids. All received bids from the hotels are summarized according to above criteria. Then customers' demands are matched with the supply of the hotels, which allows maximizing the revenue of the auction site. In case when a customer requests more than one room, a match ensures that all rooms requested by a customer are in the same hotel.

In the matching process, the system uses the Hungarian algorithm (see Figure 1) developed by Kuhn and Munkres (also known as Kuhn-Munkres algorithm). The problem is represented by a bipartite graph, $G(X, Y, X * Y)$, with weights $w(e_i)$ assigned to every edge. The set X represents buyer's room, and the set Y represents seller's room. The weight of an edge represents the mark-up money for a (buyer's room, seller's room) pair. The algorithm finds the matching with the greatest total weight.

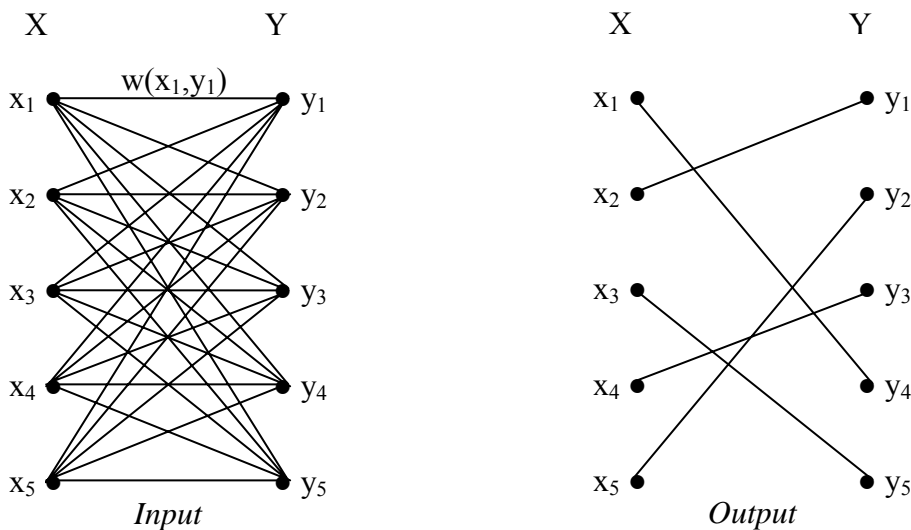


Figure 1: Hungarian Algorithm

An example of assignment problem and Hungarian method is outlined in the following matrix. The weight w_{ij} are the entries of an $n \times n$ matrix, and the elements of X and Y are

identified with the rows and columns of the matrix respectively. Let's assume that there are three requests named 1, 2, 3 and two hotels named 1, 2.

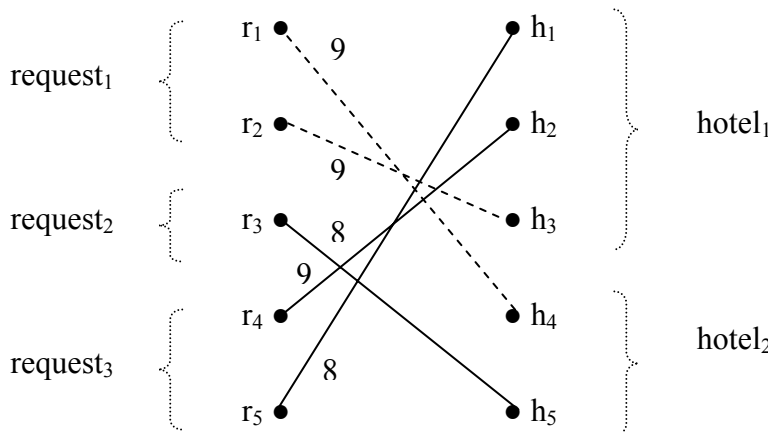
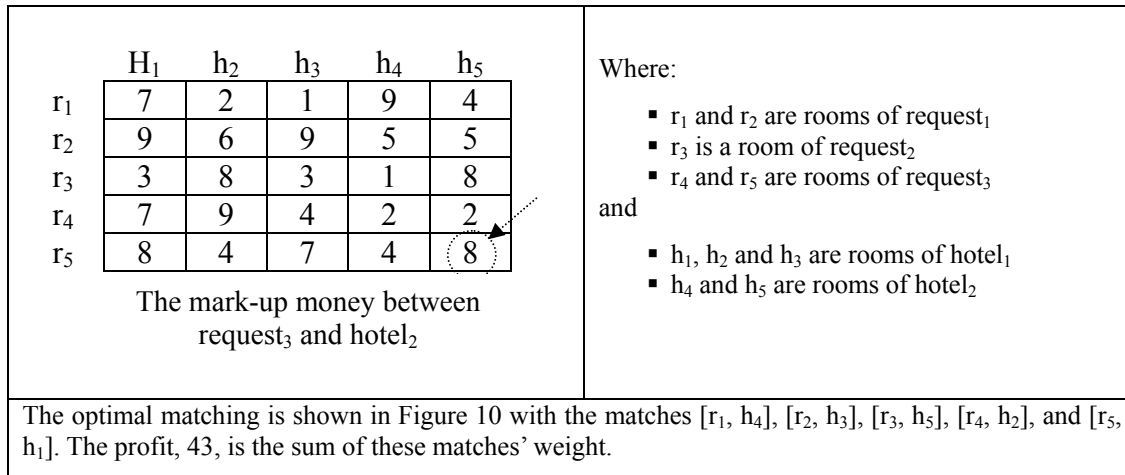


Figure 2: The Example of Hungarian Algorithm.

However, the requirement of current matching problem is more complex than the requirement of basic weighted matching. In the above example, the request₁ does not satisfy the requirements of the problem, because the request₁ is assigned to different hotels. Therefore, the result from Hungarian algorithm is not optimal but is acceptable as a temporary solution if all bad matches are being filtered. In the next step, we will use exhaustive search algorithm, particularly a Branch-and-Bound search, to get optimal solution. Using exhaustive search algorithm takes some time, so it will be formulated with the following conditions in order to quickly yield a solution.

- In the process of searching, the case that cannot yield the solution will be early eliminated.
- To get solution early, the exhaustive search algorithm has to choose the case having a better solution than the Hungarian algorithm's solution. Thus, the heuristic method will be used to implement the estimated profit function. In this function, the total

profit of all remained requests and supplies are calculated in advance. After that, the result of estimated profit function will be added to the current profit and compared with temporal solution, the lower bound from Hungarian method's solution.

Using exhaustive search, a customer's request may or may not be satisfied by hotels. Therefore, the type of exhaustive search where each node will be considered as a feasible solution.

IV. Prototype Implementation

The Last-Minute auction prototype is implemented based on the following technologies:

- Platform: Windows XP Professional is used as operating system at client side and Windows 2000 Advanced Server is used as operating system at server side.

- Web Server: Microsoft IIS 5.1 (Internet Information Service) is used to manage the website.
- Database Server: Microsoft SQL Server 8.0 is used to manage all the data of the auction.
- Software Development Tool: Microsoft Development Environment 7.1 and Microsoft .NET Framework 1.1 are used to develop the application. ASP.NET (Active Server Pages) is used as a technology to build the application.
- Aid Tool: Rose Enterprise Edition 2002.05.00 is utilized to analyze and design the application.

The interface of proposed Last-Minute auction is divided into three parts: customer interface, hotel interface and auction site administration interface.

V. Conclusion

The Last-Minute auction was designed and implemented for auctioning vacant hotel rooms. From the customers' perspective, its bidding mechanism permits them to specify their requirements and join the Last-Minute auction. From the sellers' perspective, the Last-Minute Auction helps them sell quickly vacant rooms with reasonable rates. Sellers or hotels can decrease their bids to compete successively with others and win the bids. For the auction site, the proposed mechanism helped them earn maximum revenue through the proper matching of customers' demand and hotels' supply.

The matching algorithm was designed to solve the complex problem of having many matching criteria, such as the same city, area, hotel star rating, number of room and rate. The combination of Hungarian algorithm and Branch-and-Bound search has yielded the accurate answer, which satisfied the requirements of the problem. Another solution for the weighted matching problem and the profit optimization, which has not been examined yet, is Genetic Algorithm. The solution generated by Genetic Algorithm can be a direction of the future work.

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