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An Application of New Approach for Dynamic Orders Selection to Maximize Restaurant Operational Profits

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Abstract. Restaurant dynamic orders selection problem is an important issue in operational profits. Restaurant managers face many pressures, i.e. cook facilities and customer satisfaction, etc., therefore, they schedule orders in a manual (First-come-first-serve) way and do not willing pay more attention to orders selection problem. In order to satisfy customer's needs, restaurants always loose profits day by day due to add more manpower and equipments. The main purpose of this research is to construct a dynamic order selection approach to maximize a restaurant profits. This study followed cloud computing approach for solving applied mathematic research topics. The proposed new approach, it hybrid Apache server and PHP coding techniques; furthermore, it contained the optimization tools, which were coding by this study using PHP language to precede revised simplex methods mixed branch-and-bound algorithm. Through validations, we found that the proposed approaches would help to increased 214% profits in practical restaurant. Future research suggests applied this approach to others industries' dynamic orders selection problems.

Introduction

Restaurant orders selection issue were fewer discussions in international research database. Most of existing related papers were discussing scheduling fast food restaurant service [1]. In the real world, First-come-first-serve (FCFS) maybe a golden rule for service industries, however, some special topic restaurant maybe not following this rule. Choosing the maximum profits orders of a restaurant in hot time interval based on the restaurant capacities is the direction of discussion in this study.

Capacity constraints were ever discussion in many domains. In food service industries, the purpose of orders selection is to maximize the company profits, minimize the food materials long term storage in warehouses, manpower waste and un-welcome orders (Their real purpose does not have meals in a restaurant.) Restaurants are also new popular research subject in service industries. It's related to personnel, cook facilities, restaurant layout [2], cost control and customer satisfaction, etc. In most restaurants, they schedule orders in a manual (First-come-first-serve) way. The production sequence did not based on optimization plans, costs of a restaurant would increase. Restaurant managers are under a lot of pressure to complete the cooking and delivery dishes on time. In order to satisfy customer's needs, restaurants always loose profits day by day due to add more manpower and equipments.

Over ten years ago, Ho and Wang [3] applied object oriented programming skills to food and beverage production scheduling problem. In their research, satisfaction of customers need was an important issue. Customers did not want to delay of delivery their food. Nowadays, the main purpose of this research is to construct a dynamic order selection approach to maximize a restaurant profits.

Problem Formulation

This research adapts maximization of restaurant profits as an indicator to ensure a batch of cumulative inputting orders at certain time would find an optimal solution. If it is not the first batch of inputting orders, the computer will remove the orders which were completed processing. Thus, the computer software can real time processing new inputting orders.

Let j denote order number. Let n denote number of orders at t stage. Let P_j denote profit from order j. Let x_j denote a binary decision variable, if order j is selected, then equal to 1; otherwise equal to 0. Let w_j denote weight of order j (it represents consuming x unit of resources). Let Cap denote restaurant capacity [4,5,6], it would be cook facility constraints or manpower [7,8] for orders constraint, etc. This study simplified the complex problem as several Knapsack Problems. In each batch of cumulative inputting orders at t stage, it showed as follows:

j : order number
n : number of orders at t stage
P_j : profit from order j

$$x_j = \begin{cases} 1, & \text{if order } j \text{ is selected} \\ 0, & otherwise \end{cases}$$

w_j : weight of order j (it represents consuming x unit of resources)

Cap : restaurant capacity

The MILP model to maximize restaurant profits (RP) for restaurant orders selection is as follows:

$$\textbf{Max} \quad RP = \sum_{j=1}^{n} p_j x_j \tag{1}$$

s.t.

$$\sum_{j=1}^{n} w_j x_j \le Cap \tag{2}$$

$$x_j \in \{0,1\} \tag{3}$$

The objective (1) is to find a maximum restaurant profits. In Eq. (2), these are *Capacity* constraints. In Eq. (3) declares artificial binary *decision* variable constraints.

Methodology

In recent global research hot topics, cloud computing is a trend and on-line computing (It represents we have not much computation time.) hybrid parallel server processing almost becomes a new industrial standard. Therefore, this study followed cloud computing approach for solving applied mathematic research topics.

The experiments preceded the global optimal solution on the basis of the revised simplex methods and branch-and-bound approach. The software (RS&BB) were coding by this study using PHP language and Apache server interpreter. Because it is the first time used for academic research, the software was compare to lp_solve5.5 (for command line mode) software, which is coding by (C++) complier program in global academic institutes and mathematical societies. The primitive's validation showed RS&BB had the same optimal solution with comparing results to lp_solve5.5 in smaller problem sample size; however, dynamic orders selection involves hybrid others algorithms for co-computing; the general optimization software, such as lp_solve, Lingo 10, XpressMP, ILOG-CPLEX,or Matlab 2010, were not suitable directly dealing with uncertain orders and real-time style on-line processing, thus this study coding RS&BB by PHP for could computing. Besides, in BB process, a better lower bound would shorten searching time for obtaining optimal solution. The software also allowed setting a lower bound.

There are *n* orders that have to be selected, the model of this study is mixed integer linear programming (MILP) model. The artificial decision binary variable *x*, it would form a NP-hard problem because the problem have to process 2^n brand-and-bound search (if we do not adapt lower bound of BB) for obtaining integer solution. If orders *n* greater than a certain number, the computation ability of current computer would not deal with this problem, it had already proven in [9,10]. Therefore, in order to avoid the trials of factorial possibilities, this research should propose a new algorithm or approach to solve this optimization problem. Besides, the software should get an acceptable solution within a short and feasible on-line waiting time. The proposed new approach (See Fig.1) stated that a flow chart of orders selection process. In the beginning, the software screen how many orders in queue. Then based on software (RS&BB) picked up target orders. If appeared remaining orders, it represented capacity of the system is at full. We should sacrifice some orders and mobile phone them the restaurant is full. If the customers remain want to wait, then book them as VIPs for the next service iterations.

Computation Results and Discussion

The experiments proceeded on the basis of the proposed model and approaches. The proposed model contained binary decision variables and numerous capacity constraints. There were three categories in restaurant capacity constraints, i.e. manpower, preparation of food materials and kitchen equipment. The results were showed in Figure 2. The study used a desk computer with Intel Core i5-2400S 2.50 GHz CPU and 2 GB RAM computer for the computations. The restaurant profits listed in Table 1. Most restaurants used first-come-first-serve rule; In table 1, we can find that order selection system outperformed and increased 214% profits. It stated that we should choose the profitable orders to receive and, if possible, reduce unnecessary waste from manpower, materials, un-welcome orders, etc.

Conclusion

Restaurant dynamic orders selection problem is an important issue in restaurant operational profits. Restaurant manager faces many pressures, i.e. personnel assignments, cook facilities, restaurant layout, cost control and customer satisfaction, etc.; thus in most restaurants, they schedule orders in a manual (First-come-first-serve) way and do not willing pay more attention to orders selection problem. In order to satisfy customer's needs, restaurants always loose profits day by day due to add more manpower and equipments.

In this study, we first construct a restaurant profits (RP) model for orders selection. Through validations, we found that the proposed approaches would help to increased 214% profits in practical restaurant. However, it may results in different profits if some of the capacities are revised. Future research suggests applied this approach to others industries' dynamic orders selection problems.

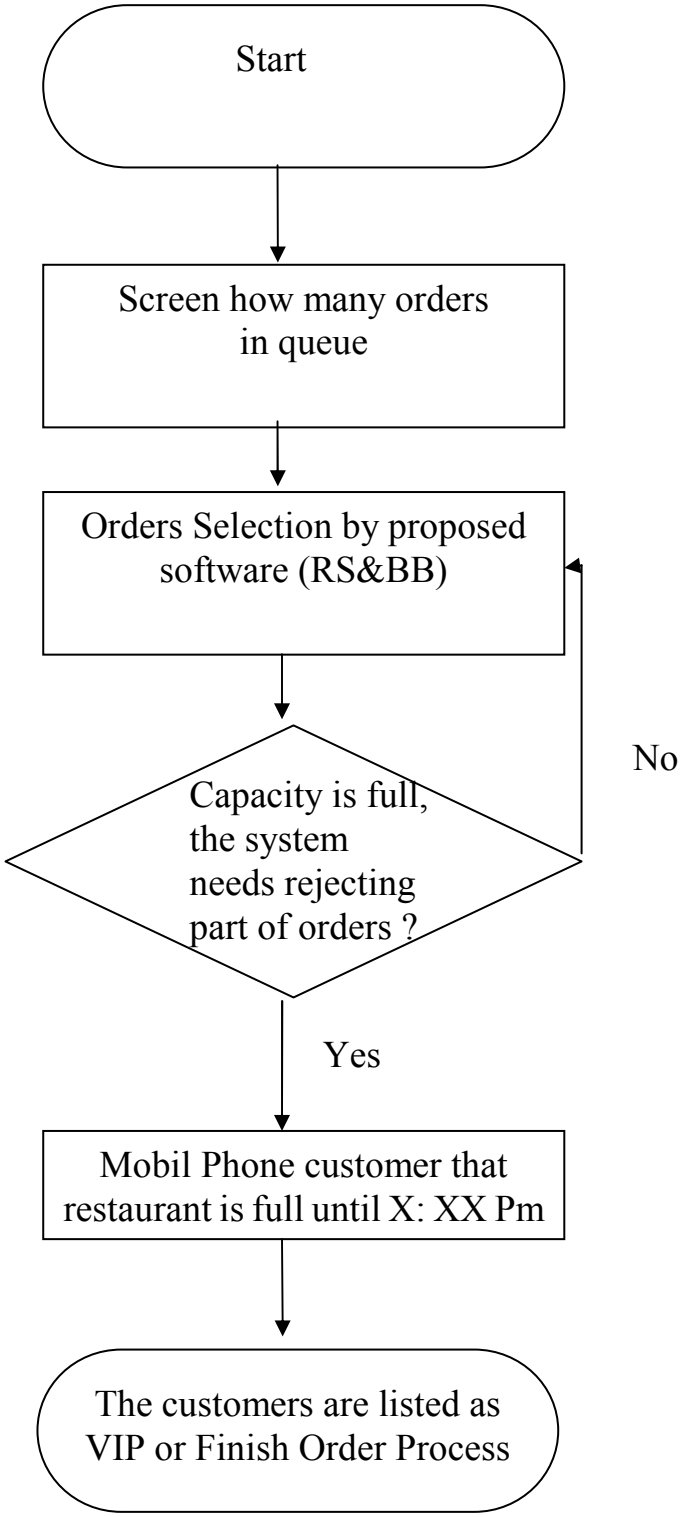

Fig. 1 A flow chart of proposed orders selection approach

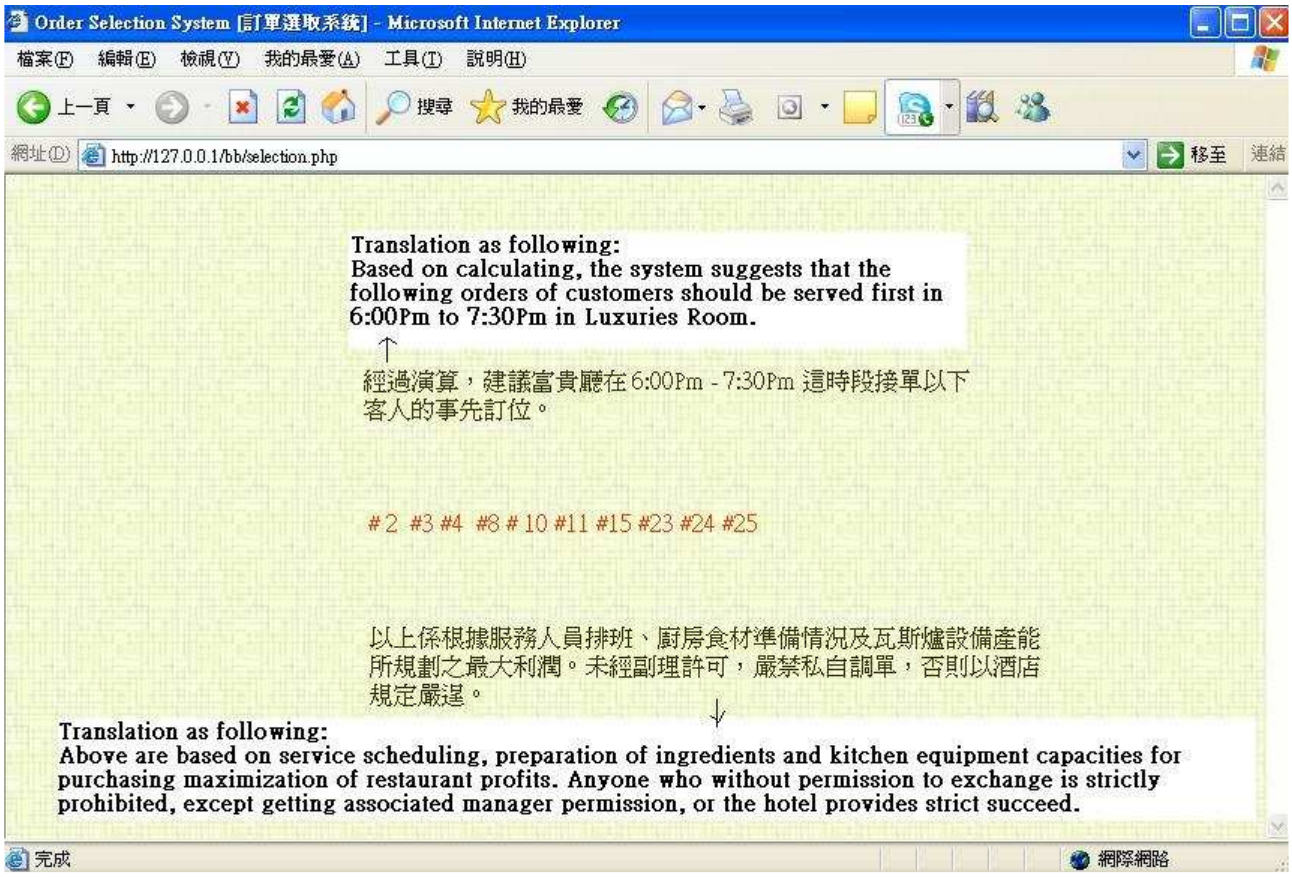

Fig. 2 Output of Proposed Software for Restaurant

Table 1 Restaurant Profits

Approach	Profits (unit)
FCFS	49
Proposed approach	154
Increase rate	214%

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