



A Revenue Management System to Book Airline Seats Using Genetic Algorithm

Rosey Popli

Student (M.tech) Department of Computer Science and Applications
Kurukshetra University, Kurukshetra, India

Abstract— this paper presents the revenue management strategies specific to the airline industry in order to book the seats of the airlines as well as to achieve the maximum revenue. In this paper a system is proposed which tries to maximize the profit of the airlines by optimizing the system using genetic algorithm. Whenever customer made a request for booking, this request is analyzed by the system, and then according to the prefix criteria it is decided that the request should be accepted or not. If the customer’s request contributes maximum among the other requests then the request of that customer is accepted. Genetic algorithm is used as an optimization tool for the proposed system and the system is implemented using ‘mat lab’.

Keywords— revenue management, yield management, genetic algorithm, airline reservation

I. INTRODUCTION

The proposed system is an optimized system to maximize the profit of the airlines. This system is based on the concept of the yield management which states that the maximum profit should be earned from the perishable resources and the resources should be sold to the right customer at the right time for the right price. So, keeping this concept in mind, a system is proposed which results in the maximization of revenue for the airlines. The objective of yield management is to maximize the profit from the perishable resources where perishable resources are those resources which go bad after a short period of time. So the resource utilization can be optimized. The resources can be airline seats, hotel room reservations, inventory, insurance, telecommunications etc.

II. STATEMENT OF THE PROPOSED SYSTEM

In this system an application is taken to book seats for the customers in the airlines. So there are number of customers requesting for the seats reservation from different terminals. There is a booking terminal which accepts the request of one customer among various requesting customers; requesting at the same time. The request from the terminal is accepted which contributes maximum to the revenue, so as in the profit also. In this way the profit can be maximized. There should be some mechanism to reject the request; rejection means to show the unavailability. If the request of each terminal is accepted all the seats are booked at very low cost and may be all seats are booked within few days of first month. Even the maximum limit of the seats to be booked is defined still there is a risk that up to that limit a large number of seats are booked at low cost. As the fare depends upon the customer type, number of seats requested and time slot. So there can be the situations in which low fare seats are booked and high fare seats are rejected when all seats are booked. So a system is proposed which accepts the request by applying GA to achieve optimization of revenue. Only one request is accepted out of number of terminals. And it can be seen that by applying this approach revenue is maximized.

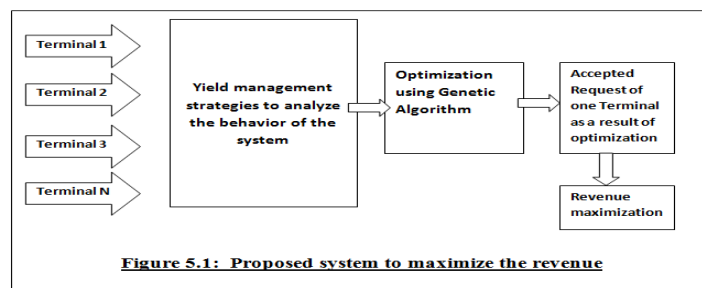


Figure 5.1: Proposed system to maximize the revenue

III. BASIC ASSUMPTIONS FOR THE SYSTEM

The basic assumptions for the system are based on the analysis of the system by using yield management strategies like data collection, analysis, and segmentation then further forecasting. Yield management strategies help to understand the system completely. It helps to get the full knowledge about the system behavior by studying the historical data. The historical data is very important to make some assumptions about the system and it is easy to categorize various factors of the system based on past data. Those factors are as follows:

- A. **Terminal:** There can be any number of terminals which can raise the request for booking the seats in the aircraft for the particular flight. Customer can make a request from any terminal at any place either far or near. The maximum limit of requested seats by a terminal at one time should be fixed.
- B. **Seats:** Total number of seats in the aircraft is fixed. Initially the remaining seats are equal to the total number of seats. Number of seats will be decremented each time a request is accepted.
- C. **Customers:** There can be number of customer classes. Customers can be categorized on the basis of their priorities and the fare they can pay etc. For example there can be leisure customers and business customers. It can be assumed that the business customers can pay more.
- D. **Time:** The total number of booking period must be specified i.e. the customer can raise the request for the reservation during this time period before the flight takes off. The total time period must be divided into time slots. The fare should be corresponding to the slots. Slots may have different fares; the customer has to pay the fare according to the time (slot). The fare will be increased from moving one slot to another means as the time reaches near to the flight take off time. For each slot the total number of booking that should be accepted is fixed, by specifying the upper limit and lower limit of the booking.
- E. **Fare:** For each requested seat the customer has to pay the fare. The fare can be different for different customers depending upon the type of customer and the time of request for e.g. fare for the business customers are higher than the leisure customers. There is a discounted fare for the seats which remains unbooked before some hours of the flight takes off, so these seats are required to be sold on discount.
- F. **Revenue:** Initially the total revenue is 0. Total revenue will be increased each time a booking is made. Target is to maximize the revenue by selecting best request among number of requests made at same time. [1]

IV. TECHNIQUES USED FOR IMPLEMENTING THE SYSTEM

A.1 Yield management

Yield management is the process of understanding, planning and implementing the strategies for a particular resource so that the profit from these resources can be maximized and resources are utilized effectively.

Yield management is applicable under these conditions:

- There should be fixed amount of resources available for sale.
- Resources sold are perishable (there should be a time limit to sell the resources, after that time limit, the resources would go unused and their value becomes null).
- Different customers are willing to pay a different price for using the same amount of resources.
- The firm should be able to distinguish between the customer classes, as each class has different demand criteria as there can be business customers and leisure customers.

Good yield management system maximizes revenue production for the same number of units, by taking advantage of forecast of high demand periods, low demand periods and price sensitivity of the customers. Generally, yield management system mainly depends on four factors:

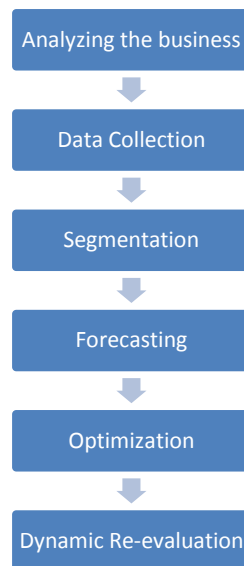
- I. **Services/Products:** Services or Products are the resources that depend upon the type of firm. For example in airlines, the resources can be the number of seats in airplane, number of members to be assigned for the crew etc. In hotel room reservation the resources are number of rooms. Yield management deals with how, when and to whom these services are delivered. And also checks that whether the particular service is reserved, if yes, then how and when it is reserved and at what criteria (mainly time and price).
- II. **Timing:** To achieve the goal of yield management that is to maximize profit timing plays a vital role. To fulfill this demand we must ensure some time strategies. Ideally, every business organization seems the customer as a king and they consider that the customer will put their demands on time (when the reservation is open) and also arrive according to their fixed (allocated) schedule respectively and the business organization let them pay according to their demands. But in reality this mechanism probably gets failed. So to get rid of this uncertain behavior of the customers the business management relies on the following factors: Overbooking, Penalties for cancellation, Advance payment, Shifting of customers. There are two situations for which the time is recorded:
 - Timing when the customers place the order for the service/product
 - Timing of the service/product delivery
- III. **Price:** Price depends upon the type of the service, timing of the reservation and other factors related to products/services. The price can be set according to the time when the service is reserved and when the service is delivered. Every business organization provides different kinds of services to their customers and in the respect of this they can make the customers to pay for the different service. Business organization preliminary fixed the price of every service. The benefit of fixing preliminary is totally goes to business organization, because the customer has to pay the specified price for the particular service in order to get that service.
- IV. **Customer:** Customers can be characterized according to their demands for the service/product which depends upon the timing, price and type of services. The customers can be price sensitive (leisure customers) and price insensitive (business customers). Price insensitive customers are those who can pay top dollar to use a service at their required time, while price sensitive customers take advantage of lower prices during non peak times. [3]

A.2 Process of airline yield management:

In order to implement effective yield/revenue management system, first of all we have to know the products and services specific for the company. What are the pricing techniques and how these pricing techniques may affect the company targets and customer segments? Another major requirement is that there should be excellent data quality

because the utilization of incorrect and poorly collected data will lead to wrong estimates and forecasts. This may cause the incorrect interpretations and may also effect the financial position of the company. Companies, who want to implement revenue/yield management system, are required to follow these steps:

- Analyze the business and make a business case and model to be followed
- Estimate the service or product price
- Adopt a revenue management system
 - Collect and store the historic data in the system
 - Forecast the future booking on the basis of historical data
 - Implement the system based on the strategy based on the decisions of previous steps(especially historical data)
- Optimization



B. Genetic Algorithm

Genetic Algorithm is an adaptive heuristic search algorithm that mimics the process of natural evolution. Genetic algorithm is used to solve the optimization and search problems. Genetic algorithm belongs to the evolutionary algorithms which are used to generate the solution of the optimization problems using techniques of natural evolution like inheritance, selection, mutation, and crossover. In genetic algorithm there is a population which consists of candidate solutions for an optimization problem which is evolved towards the better solution. In genetic algorithm there is a population of randomly generated individuals, the fitness of every individual is calculated; the best fit individual will be selected from the current population. Each individual's genome is mutated or recombined to form a new population. The new population is used in the next iteration of the algorithm. The algorithm will terminate when the satisfactory level of fitness is reached. Yield management is also an optimization problem, where the genetic algorithm can be suitably applied to get the optimum result like maximizing profit and minimizing cost functions. The yield management can be solved using any traditional optimization and search methods but GA is more effective as the traditional optimization and search methods move from one point to another in the search space based on some rule, which results in a local optimum in a multi dimensional space. Whereas GA works with a population, which represents a number of points in the search space thus increases the possibility of the getting the global optimum solution.

The basic genetic algorithm is as follows:

[Start] Genetic random population of n chromosomes (suitable solutions for the problem)

[Fitness] Evaluate the fitness $f(x)$ of each chromosome x in the population

[New population] Create a new population by repeating following steps until the new population is complete

[Selection] Select two parent chromosomes from a population according to their fitness (the better fitness, the bigger chance to get selected).

[Crossover] With a crossover probability, perform crossover to the parents to form a new offspring (children). If no crossover was performed, offspring is the exact copy of parents.

[Mutation] with a mutation probability, mutate new offspring at each locus (Position in chromosome)

[Accepting] Place new offspring in the new population.

[Replace] Use new generated population for a further sum of the algorithm.

[Test] If the end condition is satisfied, stop, and return the best solution in current population.

[Loop] Go to step2 for fitness evaluation. [2]

C. MATLAB

MATLAB (matrix laboratory) is a numerical computing environment and fourth-generation programming language. Developed by Math Works, MATLAB allows matrix manipulations, plotting of functions and data, implementation of

algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, Java, and FORTRAN. Although MATLAB is intended primarily for numerical computing, an optional toolbox uses the MuPAD symbolic engine, allowing access to symbolic computing capabilities. An additional package, Simulink, adds graphical multi-domain simulation and Model-Based Design for dynamic and embedded systems. MATLAB can be used for a range of applications, including signal processing and communications, image and video processing, control systems, test and measurement, computational finance, and computational biology and optimization. More than a million engineers and scientists in industry and academia use MATLAB, the language of technical computing. MATLAB is the foundation for all products, including Simulink. You can extend MATLAB with add-on products for: Parallel Computing, Math, Statistics, and Optimization, Control System Design and Analysis, Signal Processing and Communications, Image Processing and Computer Vision, Test and Measurement, Computational Finance, Computational Biology, Code Generation and Verification, Application Deployment, Database Connectivity and Reporting.

V. HOW SYSTEM WORKS

- The system receives multiple requests for the booking of seats. Among those requests the system will accept the request of the terminal which contributes the maximum in the revenue.
- The decision of choosing the terminal is done by using the genetic algorithm which gives the optimized result.
- Using Genetic Algorithm, the terminal whose fitness value is higher will be accepted.

The proposed system is explained by taking a suitable example. This example shows; that how the request is accepted from a terminal by the system in order to maximize the revenue. This example consists of 3 terminals. In each step the request from one terminal is accepted among the three terminals. And the system is optimized using genetic algorithm. Following assumptions are made for the taken example:

- 1) Total number of Terminals = 3
- 2) Types of customers = 2 (Business Customer, Leisure Customer)
- 3) Total booking period = 3 months
- 4) Time slots = 4 (slot 1(1st month) , slot 2(2nd month), slot 3(3rd month, slot 4(few hours before flight takes off))
- 5) Initial total revenue = 0
- 6) Total seats = 70
- 7) Initial remaining seats = 70
- 8) Maximum booking allowed to the customer at one time = 3
- 9) Minimum Booking for a month = 18
- 10) Maximum booking for a month = 30
- 11) Fare for the business customer and leisure customer are shown in table.

Business Customers (customer type 2)	Terminal 1	Terminal2	Terminal3
Month1	1500	2000	2500
Month2	2000	2500	3000
Month3	2500	3000	3500

Leisure Customers (customer type 1)	Terminal 1	Terminal2	Terminal3
Month1	1000	1500	2000
Month2	1500	2000	2500
Month3	2000	2500	3000

Now the front task is to book the airline seats. But the main task that runs behind parallel with the front task is to maximize the profit while booking the seats. So according to the example the following requests are generated to book the seats:

Month1:

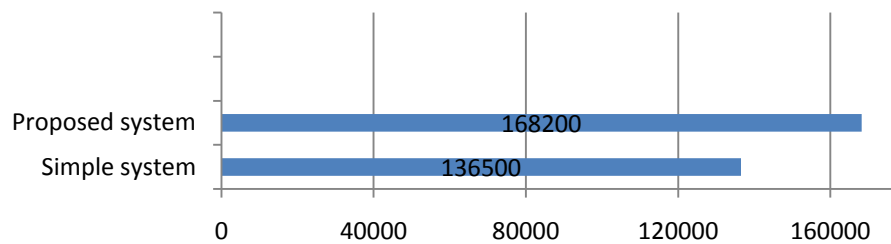
Terminal1: customer type-2, number of seats- 1

Terminal2: customer type-2, number of seats- 2

Terminal3: customer type-1, number of seats- 1

Among these three requests, one terminal is selected as this request is passed to the proposed system and proposed system find out the optimized result. The system gives the output as a terminal which contributes maximum to the revenue. In this example the second terminal is selected. The revenue generated by the three terminals are 1500, 4000 and 2000. The second terminal is selected out of the three terminals because it contributes maximum in the revenue. Similarly the requests are accepted for every month until all the seats are booked or the time period for booking is finished. Every time the system selects the best terminal out of the requested terminal. In this way at last the system generates the maximum possible revenue.

The fitness function that is used in genetic algorithm to find out the best terminal is revenue = no. Of seats * fare
Fare depends upon the customer type, time of request and terminal. For this example the total revenue generated for the 70 seats is 168200 where as the revenue generated by the simple booking system is 136500. The result can be shown by graph also:



VI. CONCLUSION

Revenue management is very important concept of business management techniques. By which various resources or yield of a business is managed. Every business demands the highest revenue should be achieved. The objective of yield management is to maximize the profit from the perishable resources where perishable resources are those resources which go bad after a short period of time. In this work a system is proposed to maximize the revenue of the airlines. As competition and various economic pressures increases, all airlines, full service, and low cost carriers alike need to maximize revenue in order to succeed and grow. As airlines adapt their business processes and models to meet the current challenges facing the industry, revenue management provides a number of strategies to help increase and maximize revenue. The proposed system is an optimized system to maximize the profit of the airlines. In this system we have taken an application i.e. booking seats for the customers in the airlines. So there are number of customers requesting for the seats reservation from different terminals. There is a booking terminal which accepts the request of one customer among various requesting customers; requesting at the same time. The request from the terminal is accepted which contributes maximum in the revenue, so as in the profit also. In this way the profit can be maximized. There should be some mechanism to reject the request; rejection means to show the unavailability. If the request of each terminal is accepted all the seats are booked at very low cost and may be all seats are booked within few days of first month. Even the maximum limit of the seats to be booked is defined still there is a risk that up to that limit a large number of seats are booked at low cost. As the fare depends upon the customer type, number of seats requested and time slot. So there can be the situations in which low fare seats are booked and high fare seats are rejected when all seats are booked. So a system is proposed which accepts the request by applying GA to achieve optimization of revenue. Only one request is accepted out of number of terminals. And it can be seen that by applying this approach revenue is maximized.

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