Airline Management Optimization using Genetic Algorithm

Parul1 Tarun Ahuja2
1Student (M.tech) Department of Computer Science and Engineering
Shri Baba Mastnath Engineering College, Rohtak
2Assistant Professor (Mtech) Department of Computer Science and Engineering
Shri Baba Mastnath Engineering College, Rohtak

Abstract— The paper reflects the retrospection in management is to maximize the profit from the decomposable resources. There can be many solutions to implement yield management like linear programming, simulation, decomposition method, genetic algorithm, etc. In this paper counsels a system which tries to maximize the profit of the airlines by optimizing the system using genetic algorithm. Whenever customer makes a request for booking, this request is analyzed by the system, and then as per the predefined criteria, it is decided whether the request is to be accepted or not. If the customer’s request contributes maximum among the other requests then the request of that customer is accepted. The system is implemented using 'mat lab'.

Keywords— revenue management, yield management, genetic algorithm, airline reservation, decomposition method, linear programming.

1. INTRODUCTION

The introduced system is an optimization 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 decaying resources and the resources should be sold to the right customer at the right time for the right price. So the resource utilization can be optimized. The resources can be airline seats, hotel room reservations, inventory, insurance, telecommunications etc.

2. STATEMENT OF THE COUNSELLED 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.

Target is to maximize the revenue by selecting best request among number of requests made at same time. [1]

3. TECHNIQUES USED FOR IMPLEMENTING THE SYSTEM

A. 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.

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)

1. Techniques to implement Yield Management System

A.1 Linear Programming

Linear programming or linear optimization is a mathematical method for determining a way to achieve the best outcome (such as maximum profit or lowest cost) in a given mathematical model for some list of requirements represented as linear relationships.

A typical mathematical problem consists of a single objective function, representing either profits to be maximized or costs to be minimized and a set of constraints that circumscribe the decision variables. In the case of a linear program (LP) the objective function and constraints are all linear functions of the decision variables.

Linear programs are problems that can be expressed in canonical form:

\[
\text{maximize} \quad c^T x \\
\text{subject to} \quad Ax \leq b \\
\text{and} \quad x \geq 0
\]

Where \(c^T X\) is the objective function to be maximized or minimized and \(Ax \leq b\) and \(X \geq 0\) are constraints.

A.2 Decomposition method

Yield management applications can be solved using decomposition method. In decomposition method the problem is divided into \(m\) single resource problems each contain some information about the given problem and each decomposed part is independent. It can be said that a decomposition method \(M\) decomposes the yield management problem into \(m\) single resources (leg) models i.e. model \(i=1 \ldots m\) with value functions \(P_i(x_i), \quad \text{that depends on the time-to-go } t, \quad \text{remaining capacity } x_i \text{ of resource } i\). These may be constructed by incorporating some static network information into the estimates. Then the total value function is approximated by:

\[
P(x) = \sum_{i=1}^{m} P_i(x_i)
\]

Typically, such approximations are discrete and yield bid prices

\[
p_t(x_i) = \Delta P_i(x_i), \quad i = 1 \ldots m.
\]

Where

\[
\Delta P_i(x_i) = P_i(x_i) - P_i(x_i - 1)
\]

is the usual marginal expected value produced by model \(i\).

A.3 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 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 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)
B. 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.

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; 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

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 whereas the revenue generated by the simple booking system is 136500. The result can be shown by graph also:

4. 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. 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.

REFERENCES

AUTHOR
PARUL RECEIVED DEGREE OF BACHELORS OF TECHNOLOGY FROM SATPRIYA INSTITUTE OF ENGINEERING AND TECHNOLOGY, ROHTAK. PURSUING M.TECH DEGREE FROM SHRI BABA MASTNATH COLLEGE, ROHTAK. SHE HAS PUBLISHED 2 PAPERS IN INTERNATIONAL REPUTE.