OPTIMIZATION OF AIRLINE USING GENETIC ALGORITHM

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Abstract—Yield management is the process which can be applied to various business areas to optimize the yield. 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. [1] In yield management the fixed or perishable resources are required to sell to the right customer at the right time for the right price, so that the resource utilization can be optimized. The resources can be airline seats, hotel room reservations, inventory, insurance, telecommunications etc. 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.

Keywords— Yield management, Revenue production, Perishable resources etc.

I. INTRODUCTION

The objective of yield management is to maximize the profit from the perishable resources. There can be many solutions to implement yield management like lpp, simulation, decomposition method, genetic algorithm, etc. This research shows the comparative study of these solutions and genetic algorithm is proved to be a better optimization tool to implement yield management. Genetic Algorithm is an adaptive heuristic search algorithm that mimics the process of natural evolution. It is based on the Darwin’s theory “survival of fittest”. [2] 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 [3]. 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.

II. Yield Management Strategy [4]

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.

*Figure 1: Factors Effecting Yield Management*

Generally the future demands are unpredictable, so we must store the resources for the high priority customers (for example: Business customers has the higher priority than leisure customers because business customers may pay more) in order to achieve the maximum revenue. Finally, the objective is to control the demand by means of pricing and capacity control decisions to maximize revenues from a limited capacity.

*Figure 2: Need of Yield Management*

**III. NEED OF YIELD MANAGEMENT**

Yield management provides the early prediction of customer’s behavior with keeping in mind the impulsive change and demands. To analyze the historical data so that it is easy to predict what will happen in the future.
Determine the most effective way to price and allocate resources to reach every future consumer, each and every day, making real-time adjustments as market conditions change, with the consumer in real-time.

Communicate this information instantaneously to distribution and sale outlets which deal with the consumer in real-time.

IV. 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 [5].

GA handles a population of possible solutions. Each solution is represented through a chromosome, which is just an abstract representation. Coding all the possible solutions into a chromosome is the first part, but certainly not the most straight forward one of a Genetic Algorithm. A set of reproduction operators has to be determined, too. Reproduction operators are applied directly on the chromosomes, and are used to perform mutations and recombinations over solutions of the problem. Appropriate representation and reproduction operators are really something determinat, as the behavior of the GA is extremely dependant on it.

V. CHARACTERISTICS OF AIRLINE YIELD MANAGEMENT

Relatively fixed capacity: The reason for this characteristic is very simple; if capacity were flexible then there would be no need for trade-off. If airlines would add or remove, there would be no reason to
try to manage capacity. But the plane cannot be enlarged; the only flexibility allowed is to schedule the passenger on a later flight.

**Ability to Segment Markets:** Another characteristic of yield management is the smooth distribution of passengers the airline must be able to segment its market into different passenger categories. Keeping in mind that we seek a trade-off between maximum load factor and highest paying passengers, a very good example is the comparison between the time-sensitive business person and the price-sensitive customer. One is willing to pay a higher fare in exchange for flexibility (open return, cancellation option, schedule change, etc.) the other is willing to give-up some flexibility for the sake of a cheaper ticket (stay overnight Saturday, not come back on Labour Day - which is a peak day). Such a strategy allows airlines to fill seats that would otherwise be empty.

**Perishable Inventory:** In the airline industry, plane seats are referred to as inventory. If the plane leaves the gate with empty seats, this inventory cannot be stored and is lost. If an airline can minimize the inventory spoilage, then it will operate much more efficiently. Since yield management determines the load level to try to maximize revenue, we see why businesses that deal with perishable inventory can benefit from such a technique.

**Product Sold in Advance:** If all tickets were sold at once, the right trade-off would be a fixed figure and would not take advantage of customer behavior. Since customer demand level patterns vary continually over time, it makes sense to also try to find the best trade-off over time. Airplane fares change all the time, some on an hourly basis others on a weekly basis. The tradeoffs occur when a manager is faced with the option of accepting an early reservation from a customer who wants low price, or waiting to see if a higher paying customer will show up.

**Fluctuating Demand:** Yield management is a tool that can be used to smooth the demand pattern. In peak season, the airline can increase its revenues by increasing the fare on its tickets and in low season, it can increase capacity utilization by offering low prices. Past years data will offer the manager a way to forecast when these peak and low seasons occur. Demand fluctuates seasonally (peak season in the summer and low season in the fall) and also gradually (there is an increase in the demand for reservation until a few days prior departure).

**Low Marginal Sales Costs and High Capacity Change Costs:** We have already talked about fixed capacity, but it is not enough in this case. In order for yield management to work optimally, additional capacity should be expensive to acquire. In this situation, the cost of a plane is high; moreover, the lag between the order and delivery is significant. On the other hand, the cost of an additional passenger should be low (in fact, airlines have very high fixed costs), such as the negligible cost of drinks and food for a customer. In fact, if there were low capacity change costs, it would be easy to adapt quickly by storing a few airplanes.

**Consider the airline industry**, a businesses with a perishable inventory or business dealing with seasonal services and articles. For than timing is all-important. When demand varies over time, a business has both the opportunity to raise prices during periods of strong demand and they run the risk of excess inventory when demand is weak. If we compare this for example to a supermarket and the demand of a certain product is high, there is the possibility of replenishment. When the price of a product is too high and no one buys it, there is the possibility to lower the price. Back to the airline industry, there is no possibility to add extra seats to the airplane when the demand is high and there is fixed capacity. The ticket for a flight has to be sold before the plane takes off. Once the plane has
departed, the unsold seat inventory has no value and the product or service is perishable. That means that there are high fixed or sunk costs. In our supermarket this is not the case. The basics that make the difference for companies to use Revenue Management are: a) perishable inventory, b) fixed capacity, and c) high fixed or sunk costs.

VI. OPTIMIZATION

Optimization in revenue management process is about evaluating multiple options on how to sell your product and to whom to sell your product. Optimization involves solving two important problems in order to achieve the highest possible revenue. The first is determining which objective function is to be optimized. Secondly the business must decide which optimization technique to utilize [6]. The objective function is the function which gives output in terms of revenue in the case of airline revenue/yield management. So this function must depend upon the factors that directly affect the revenue of the airlines. And further this objective function is optimized in order to get the maximum profit as the revenue is maximum the profit will be maximized. Any optimization technique can be applied to maximize the objective function. Each optimization technique has its pros and cons; the technique most suitable to the system may be adopted.

![Diagram of Revenue Management Process](Image)

**Figure 5: PROPOSED SYSTEM TO MAXIMIZE THE REVENUE**

**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.
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VI. CONCLUSION AND FUTURE WORK

Revenue management is very important concept of business management techniques. Revenue management can also be used interchangeably with yield management. By which various resources or
yield of a business is managed. Every business demands the highest revenue should be achieved. The
revenue can be maximized by applying various business strategies. Revenue/yield management is one of
them. Yield management is the process by which the yield is optimized. 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 yield management the fixed or perishable
resources are required to sell to the right customer at the right time for the right price, so that the
resource utilization can be optimized. The resources can be airline seats, hotel room reservations,
inventory, insurance, telecommunications etc. In this work a system is proposed to maximize the
revenue of the airlines.

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