Minimizing Inventory Cost in Supply Chain with Genetic Algorithm

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Abstract - Efficient and effective management of inventory is carried out through the optimization in supply chain. Thus the determination of the inventory to be held at various levels in a supply chain becomes inevitable so as to ensure minimal cost for the supply chain. Minimizing the total supply chain cost is meant for minimizing holding and shortage cost in the entire supply chain. The minimization of the total supply chain cost can only be achieved when optimization of the base stock level is carried out at each member of the supply chain. A serious issue in the implementation of the same is that the excess stock level and shortage level is not static for every period. In this paper, we have developed a new and efficient approach that works on Genetic Algorithms in order to distinctively determine the most probable excess stock level and shortage level required for inventory optimization in the supply chain such that the total supply chain cost is minimized.

Keywords - Genetic Algorithm, Inventory Mangement, Supply Chain, Modern Market.

I. INTRODUCTION

The competitiveness of a company in the modern-day market place is determined by more than one vital feature such as the decrease in lead times and expenses, enhancement of customer service levels and upgrading the product quality[2]. The business organizations have started to ponder over the supply chains due to the aforesaid factors.

A supply chain can be defined as a collection of companies offering products and services to the market[3]. A supply chain can be illustrated as an incorporation of multiple entities that work in coalition towards 1) obtaining raw materials, (2) converting these raw materials into precise end products, and (3) delivering the end products to retailers.

Acquirement of raw materials and manufacturing items at one or more factories, shipping the items to diverse warehouses for storage and in turn shipping them to the corresponding retailers or customers are all part of the conventional supply chain[4] . Therefore, a valuable coordination and merger of organizations with distinct objectives to attain a common goal can be called as a supply chain[1].

Supply chain management involves a set of procedures that aid in the proficient integration of suppliers, manufacturers, warehouses and stores to ensure appropriate production and distribution of right quantities to the right location in right time and reducing the total supply chain cost as a result in addition to fulfilling service level requirements[6].

The manufacturer, who acquires the raw materials, converts them into end products and distributes the same to the customers, is regarded as the manager of the supply chain[9]. The management of the dynamic demand is a huge process that numerous supply chain firms indented towards decreasing the supply chain costs besides enhancing customer service levels face[10].

The concepts of supply chain management incorporates a wide range of activities that support the planning, implementation and control manufacturing and the delivery processes right from the source of raw material to the spot where the end product is utilized[11] . Acute issues in supply chain management arise out of shorter product lifecycles that lead to higher demand uncertainty and the action on global markets consequently increasing the supply chain complexity.

From the operational point of view, this research addresses four problem areas including Inventory management and control; production, planning and scheduling; information sharing, coordination, monitoring; and operation tools . A steady ascent in the levels of customer service has made the efficient and effective management of inventory in the supply chain inevitable.

The overload or shortage of inventories has a notable influence on the total supply chain cost. As a result, inventory optimization has emerged one of the newest topics when the supply chain management is taken into consideration. Genetic algorithms have aided in the successful implementation of solutions for a wide variety of combinatorial problems.

II. OPTIMIZATION ANALYSIS USING GA

The proposed method uses the Genetic Algorithm to study the stock level that needs essential inventory control. The responsibility of our approach is to predict an optimum stock level by using the past records and so that by using the predicted stock level there will be no excess amount of stocks and also there is less means for any shortage.

Hence it can be asserted that our approach eventually gives the amount of stock levels that needs to be. In our proposed methodology, we are using genetic algorithm by applying single point crossover and uniform mutation for finding the optimal value.

III. SINGLE POINT CROSSOVER UNIFORM MUTATION GENETIC ALGORITHM (SCUMGA)

The algorithm is summarized as follows:

Step1: Assign values for population size, maximum generation, initial crossover probabilities, initial mutation probabilities, weight values, number of objectives, and number of variable.

Step 2: Generate initial population *P* based on population size.

Step 3: Compute the fitness value of each individual in *P*.

Step 4: If stopping criterion is satisfied then the algorithm will break.

Step 5: Combine *n* objective function into single function using weight values.

Step 6: In tournament selection [3], two individuals are selected at random and the fittest is selected into mating. Mating pool will keep the selected individuals for reproduction.

Step 7: Perform crossover and mutation. Use the single point crossover [3] to randomly select cross points and swap between individuals. Uniform mutation [3] randomly select mutate points and replace it with randomly generated value.

Step 8: The best individuals will be included in the new population for next generation. This is to ensure that the best individuals make it in to the next generation. Increment generation counter (gen+1) and go to step 3.

Single Point Crossover:

A single crossover point on both parents' organism strings is selected. All data beyond that point in either organism string is swapped between the two parent organisms. The resulting organisms are the children.

Uniform Mutation:

A mutation operator that replaces the value of the chosen gene with a uniform random value selected between the user-specified upper and lower bounds for that gene. This mutation operator can only be used for integer and float genes.

Tournament selection is a method of selecting an individual from a population of individuals in a genetic algorithm. Tournament selection involves running several "tournaments" among a few individuals chosen at random from the population. The winner of each tournament (the one with the best fitness) is selected for crossover. Selection pressure is easily adjusted by changing the tournament size. If the tournament size is larger, weak individuals have a smaller chance to be selected.

Tournament selection pseudo code:

Choose k (the tournament size) individuals from the population at random

Choose the best individual from pool/tournament with probability p

Choose the second best individual with probability p*(1-p)

Choose the third best individual with probability p*((1-p)^2)

Deterministic tournament selection selects the best individual (when p=1) in any tournament. A 1-way tournament (k=1) selection is equivalent to random selection.

The chosen individual can be removed from the population that the selection is made from if desired, otherwise individuals can be selected more than once for the next generation.

Tournament selection has several benefits: it is efficient to code, works on parallel architectures and allows the selection pressure to be easily adjusted.

IV. EXPERIMENTAL RESULTS

The optimization of inventory control in supply chain management based on genetic algorithm is analyzed with the help of MATLAB.The stock levels are generated using the MATLAB script and this generated data set is used for evaluating the performance of the genetic algorithm. Some sample set of data used in the implementation.

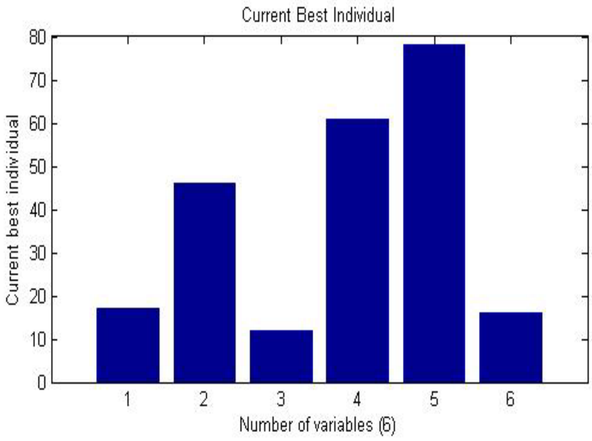
Set of data are taken and these are assumed as the records of the past period. These initial chromosomes consist of production, supply, and storage details and these are subjected for the genetic operators, Crossover and Mutation. The resultant chromosome thus obtained after the application of crossover and mutation, the resultant chromosome moved towards the best chromosome after the each iterative execution.

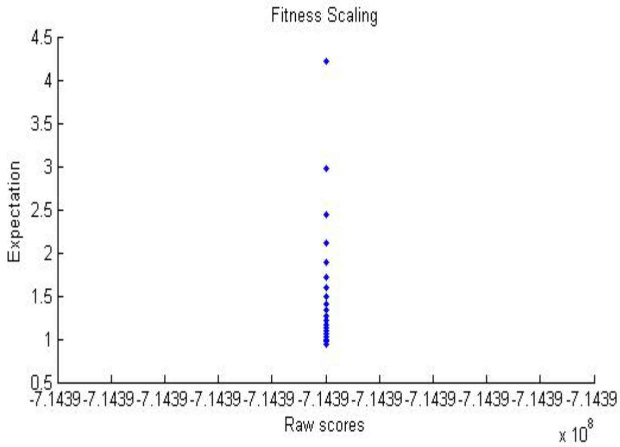
Table 1. Dataset

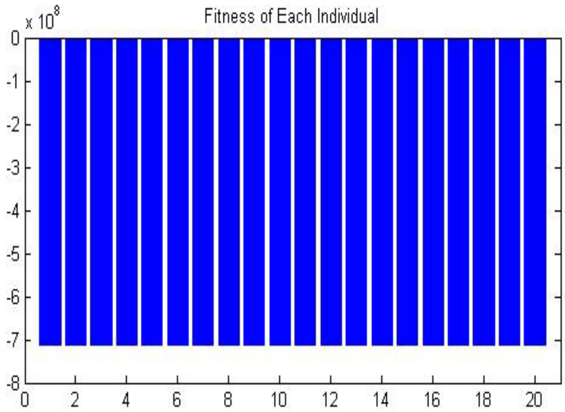
Id	Storage center 1	Storage center 2	Distribution center
1	12	31	5
2	14	35	9
3	11	36	8
4	9	38	13
5	17	45	12
6	14	46	11
7	15	41	12

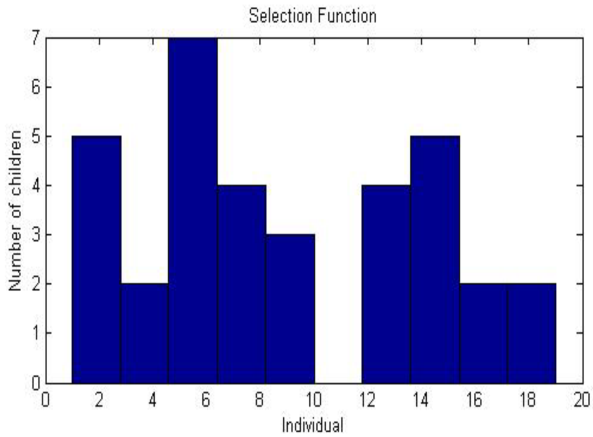
8	13	40	8

Hence at the end of the execution of 100 iterations, best chromosome '9, 31, 10' is obtained. While comparing the obtained result from the genetic algorithm with the past records, it can be decided that controlling this resultant chromosome is sufficient to reduce the loss either due to the holding of excess stocks or due to the shortage of stocks. Hence it is proved that the analysis obtains a stock level that is a better prediction for the inventory optimization in supply chain management.









V. CONCLUSION

We have proposed a innovative and efficient methodology that works with the aid of Genetic Algorithms in order to facilitate the precise determination of the most probable excess stock level and shortage level required for inventory optimization in the supply chain such that minimal total supply chain cost is ensured. MATLAB 7.4 was utilized to implement the proposed approach and to evaluate the performance.

The genetic algorithm performed well as anticipated. Thus the proposed work proffers a better prediction of stock levels amid diverse stock levels at various members of the supply chain. Henceforth the stock level obtained is the optimal value that is necessary in order to determine the stock levels needed to be hoarded at the holding points in order to ensure minimal supply chain cost.

VI. REFERENCES

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