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EXPERIMENTAL INVESTIGATIONS ON SUPPLY CHAIN MANAGEMENT PROBLEM USING SOFT COMPUTING TECHNIQUES

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Abstract. One of the central problems of Supply Chain Management is the coordination of product and material flows between locations. Important aspect in Transportation management is the coordination with the remaining activities in the firm, especially with in warehouse and customer service. Transportation of goods constitutes an important part of in-bound as well as out-bound logistics of Supply Chain Management (SCM) and a considerable portion of the purchase price of most products of services. One basic and well-known problem in transportation is the vehicle Routing Problem. A Broad range of decision ranging from raw material to finished goods falls under distribution supply chain management. Asymmetric Traveling Salesman Problem (ATSP) is one of the most difficult combinatorial Optimization Problems and so ATSP is considered with single objective function, distance traveled with a local search algorithm. A modified Hybrid Genetic algorithms approach is proposed. This paper incorporated Uniform crossover operator in Genetic algorithm for solving ATSP.

Keywords: SCM, ATSP, Hybrid GA, Modeling, Transportation.

1. INTRODUCTION

Supply Chain Management (SCM) is now at the centre stage of manufacturing and service organizations. Supply chain is the network of suppliers, manufacturing, assembly, distribution and logistics facilities that perform the function of procurement of materials, transformation of these materials into intermediate and finished products and distribution of these finished products to the customers. The task of managing the entire supply chain constitutes the core of the Supply Chain Management.

1.1 Transportation

The type of vehicles and the route to be followed by each vehicle to service customer's demands, decisions related with transportation aspect of logistics management are an important part of supply chain decisions. This analysis addresses the transportation of distribution logistics in SCM. The problem has been modelled as a classical routing problem.

One important aspect in transportation management is the coordination with the remaining activities in the firm, especially within warehouse and customer service. In some cases the transport is the last contact with the customer, and therefore, the companies should pay attention to fulfill the customer expectation and use this relationship to improve their sales. The transport coordination of the different elements of a supply chain, that can evolve different companies, can be very important since all of them most likely benefit by having a fast delivery to a specific customer. Therefore, many issues in the integration of transportation with other activities in the network can be a challenge to the academic and industrial communities.

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1.2 Supply Chain Network Distribution Problem

The most fundamental and well studied routing problem is without doubt the TSP, in which a salesman is to visit a set of cities and return to the city he started. The objective for the TSP is to minimize the total distance traveled by the salesman. The VRP is a generalization of the TSP in that the VRP consists in determining m vehicle routes, where a route is a tour that begins at the depot, visits a subset of the customers in a given order and returns to the depot. All customers must be visited exactly once and the total customer demand of a route must not exceed the vehicle capacity. The objective of the VRP is to minimize the overall distribution costs. In most real-life distribution contexts a number of side constraints complicate the model. These side constraints could for instance be time constraints on the total route time and time window within which the service must begin. The latter problem is referred to as the VRP with Time Windows (VRPTW). Furthermore, having to deal with aspects such as multiple depots and commodities complicates the models further. Solution methods include exact methods such as mathematical programming, but custom designed heuristics and meta heuristics such as Genetic Algorithm (GA), tabu search and Simulated Annealing (SA) have also been applied to the VRP.

1.3 Genetic Algorithms

A key element of what is assumed to be intelligences the capability to learn from past experience. Especially when things are done repeatedly, intelligent behaviour would avoid doing a mistake more than once and would prefer making advantageous decisions again. For optimization a class of today's most popular heuristic approaches is known as Gas. Due to its widespread use and vast amount of literature dealing with Gas, a comprehensive review of research activities is doomed to failure; thus we stick to outline of the fundamental ideas. The adjective genetic reveals the roots of these algorithms. Adapting the evaluation strategy from natural life forms, the basic idea is to start with a set of (feasible) solutions and to compute a set of new solutions by applying some well defined operations on the old ones. Then, some solutions (new and/or solutions) are selected to form a new set with which another is started, and so on until some stropping criterion is met. Solutions are represented by sets of attributed, and different solutions are met by different collections of attribute values. The decision that solutions are dismissed and which is taken over to form a new starting point for the next iteration is made on the basis of priority rule. GA can be used as problem solvers, challenging technical puzzle, basis for competent machine learning, computational model of innovation and creativity, computational model of other innovating systems and guiding philosophy.

2. GENETIC ALGORITHMS PROCEDURE

The algorithm operates through a simple cycle:

1. Creation of a population of strings.
2. Evaluation of each string.
3. Selection of the best strings.
4. Genetic manipulation to create a new population of strings.

There are four stages are interconnect in the reproduction cycle. That is Genetic operations, population, Evaluation and selection. Each cycle produces a new generation of possible solutions (individuals) for a given problem. At the first stage, a population of possible solutions is created as a start point. Each individual in this population is encoded into a string (the chromosome) to be manipulated by the genetic operators. In the next stage, the individuals are evaluated, first the individual is created from its string description (its chromosome) and its performance in relation to the target response is evaluated. This determines how fit this individual is in relation to the others in the population. Based on each individual's fitness, a selection mechanism choose the best pairs for the genetic manipulation process. The selection policy is responsible to assure the survival of the fittest individuals.

2.1 Problem Dependent Parameters

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This description of the GA's computational model review the steps needed to create the algorithm. However, a real implementation takes account of a number of problem-dependent parameters. For, instance, the offspring produced by the genetic manipulation (the next population to be evaluated) can either replace the whole population (generational approach) or just its less fitted members (steady-state approach). Problem constraints will dictate the best option. Other parameters to be adjusted are the population size, crossover and mutation rates, evaluation method, and convergence criteria.

3. GENETIC ALGORITHMS FOR SUPPLY CHAIN NETWORK DISTRIBUTION PROBLEM

In this section the design of proposed modified GA for TSP is explained. The details are explained with an example in this chapter. These are important components that are to be completely described by GA are:

- The representation format used by the GA
- The operators of crossover, mutation and reproduction
- The fitness evaluation function,
- The various parameters like the population size, the number of generations, the probability of applying the operators, etc., and,
- A method for generating the initial population.

3.1 Evaluation Function

Let u denote the original fitness, i.e., the objective value. Usually, the original fitness proportionate-reproduction scheme frequently causes two significant difficulties; premature convergence termination at early generation, and stalling at late generations. To overcome these two problems, Goldberg suggests a linear-fitness scaling scheme, $u^1 = au + b$. Lee and Johnson suggests a modified linear-fitness scaling scheme, i.e., for the lower-fitness strings, the minimum original fitness u_{max} maps to $f_{multiple}$, the average fitness u_{avg} maps tto 1. Reserchers suggested the power law scaling scheme,$u^1 = u^k$, where k is a real number which is close to one. Here we employ the well-known rank-based evaluation function, i.e.,

$$Eval(V) = a(1-a)^{rank-1}$$

Where rank is the ordinal number of V in the rearranged series. We mention that rank = 1 means the best individual and rank= pop size the worst individual.

4. ALGORITHM FOR THE PROCESS

Step 0: Set Parameters
Step 1: Initialization process
Step 2: Evaluation
Step 3: Selection operation
Step 4: Crossover operation
Step 5: Mutation operation
Step 6: Termination test

5. RESULT AND DISCUSSION

General GA process has been modified by incorporating the new crossover operator uniform crossover operator and by applying the methodlogy of double oprated crossover operator namely uniform and swap crossover operator. The different combination of crossover operator has been tested using pilot runs. The modified GA has been tested with uniform crossover operator, swap operator, insertion mutation, swap mutation and the combination of two crtossover –insertion mutation operator namely the combination uniform crossover-swap crossover-uniform crossover-insertion mutation, swap crossover-uniform crossover-swap mutation. The results are compared and it was found that the sequence of uniform crossover-swap crossover-insertion mutation operation sounds better than other combination.

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1. Percentage improvement of K-Means over GA

$$= \frac{(\text{Total cost})_{GA} - (\text{Total cost})_{\text{K-Means}}}{(\text{Total cost})_{GA}}$$

2. Percentage improvement of K-Means – GA over K-Means

$$= \frac{(\text{Total cost})_{\text{K-Means}} - (\text{Total cost})_{\text{K-Menas-GA}}}{(\text{Total cost})_{\text{K-Means}}}$$

Table: Results of Supply Chain Distribution Network Problem for GA and K-Means GA

S.No	K-Means	GA	K-GA	K-Means GA over K-Means
1	16850	20270	14830	11.9881
2	16860	19400	15360	8.8967
3	17040	21760	15080	11.5023
4	17190	18700	16590	3.4904
5	17260	18080	14630	15.2375
6	17330	20630	15420	11.0213
7	17350	19010	16560	4.5533
8	17370	20210	15240	12.2625
9	17430	20200	13150	24.5553
10	17640	21420	14460	18.0271
11	17690	20080	14070	20.4635
12	17740	21430	14100	20.5186
13	17770	22630	14480	18.5143
14	17950	22440	15470	13.8161
15	18080	22550	15500	14.2699
16	18220	19520	14630	19.7036

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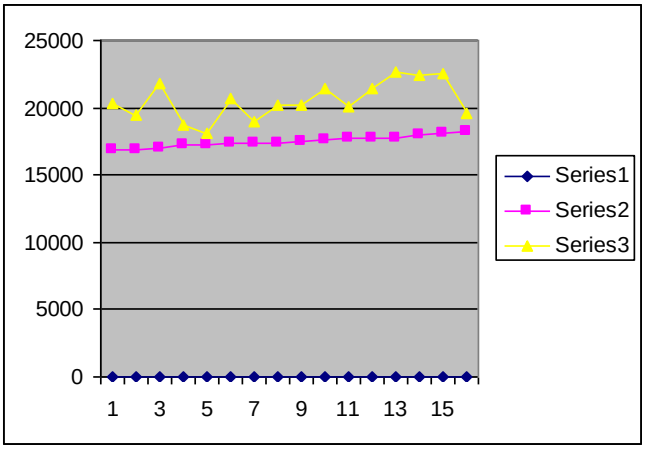

Fig 1: Comparative Results K-Means Vs GA

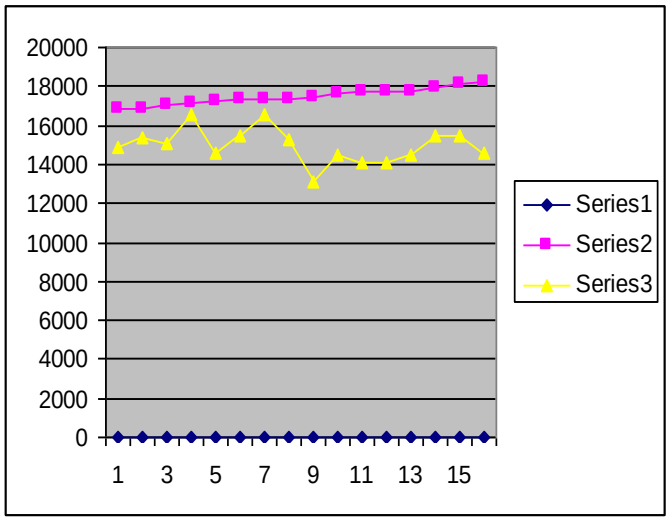

Fig 2: Comparative Results K-Means Vs K-GA

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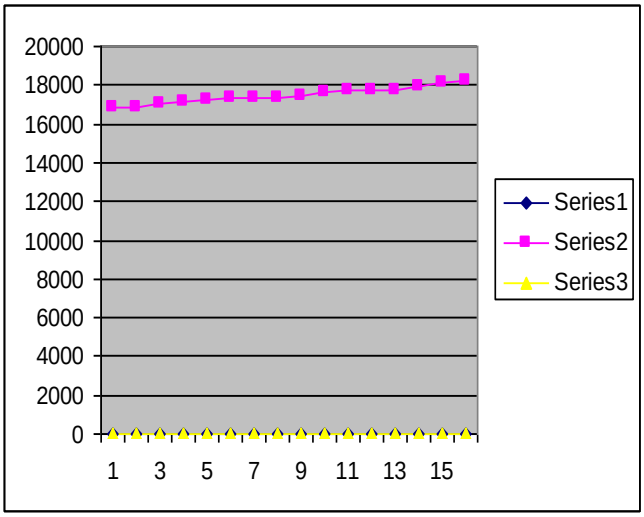

Fig 3: Comparative Results K-Means Vs GA Over K-Means

5. CONCLUSION

Modern-day optimization techniques has become a key tool in making important business decisions that can incerase the competetive advantage. As a response to the above, Modified Hybrid Genetic algorithm appraoch have been proposed and implemented to optimize the supply chain distribution network problem and analysed the problem with the same technique Genetic algorithm has been modified by incorporaing the uniform crossover operator and Swap Crossover operator namely double operated unifrom crossover operaor in the crossover process. The modified Genetic Algorithm is compared with General Genetic algorithm and the modified is proved better in obtaining nearer optimal solutions for Supply Chain Distribution Network Problem.

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