ENHANCING THE CAPABILITY OF SUPPLY CHAIN BY OPTIMIZATION OF WAREHOUSE SCHEDULING USING GENETIC ALGORITHM AND ADOPTIVE GENETIC ALGORITHM

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Abstract

Manufacturing organizations of the present time are facing the challenge of satisfying the higher expectations of the customer which are changing frequently. The challenge increases with the global competition. The customer needs the quality products/services at the lowest possible cost and within the shortest possible time. In this paper a solution to the problem of warehouse scheduling wherein the shipment cost and shipment time is optimized is presented using the Genetic Algorithm and Adoptive Genetic Algorithm.

Keywords: *Warehouse scheduling, Genetic Algorithm, Adoptive Genetic Algorithm.*

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1. INTRODUCTION

Manufacturing organizations of modern times are no more simple systems of converting a set of input resources into a useful products and services by maintaining high productivity, but they have evolved into a frequently changing complex system of satisfying higher expectations of customers. Global competition further increases complexity. In order to support its global competitiveness and higher customer expectations, an individual manufacturing enterprise has to be integrated not only with its related systems, but also with its partners, suppliers and customers.

Changing business environment requires corporations to continuously evaluate and configure their supply chains (SCs) to provide customers with high quality products/services at the lowest possible cost and within the shortest possible time. The optimization of warehouse scheduling in particular the optimization of shipment cost and shipment time will achieve the required objective and the same time enhances the capability of Supply Chain. In the present paper the Genetic Algorithm and Adoptive Genetic Algorithm are used for the optimization purpose.

2. BACKGROUND

Changing business environment requires corporations to continuously evaluate and configure their supply chains in order to sustain the global competition. The warehouse management system manages the all types of the materials in one place and delivered efficiently with the minimum time. It dispatched the materials as per the customer requests without the delay time also it maintains all information about the materials and stock list. The optimization techniques are employed to find out the minimum shipping cost and minimum shipping time.

Literature survey reveals that the Genetic algorithm is widely-used for optimization of shipping cost and time. In this work the Genetic Algorithm and adoptive Genetic Algorithm is used for optimization of shipping cost and shipping time which automatically enhances the capability of supply chain.

3. METHODOLOGY

3.1. Genetic Algorithm (GA)

When the search space becomes massive, we need a specific method to unearth the optimal solution. GA handles a population of feasible solutions and each solution is signified through a chromosome, which is just an abstract representation. In each chromosome, the fittest individuals have a better chance to produce off-springs by mixing features of the parents or by altering one or more of the parents' characteristics whereas, the bad individuals are most likely to die. Decisions that have to be made for applying GA consists individual or chromosome representation, method of crossover, probability of crossover, method of mutation, probability of mutation, and population size. The elements of the GA are populations of chromosomes, selection according to fitness, crossover to create new offspring, and random mutation of new offspring. The following flow chart shows the simple Genetic Algorithm.

The all parameters are started before the genetic algorithms and then find the fitness charge of the genetic algorithm. The chromosomes in a GA population typically take the form of bit strings. Each locus in the chromosome has two feasible alleles: 0 and 1.Each chromosome can be thought of as a point in the search space of candidate solutions. GA operators are selection, crossover and mutation.

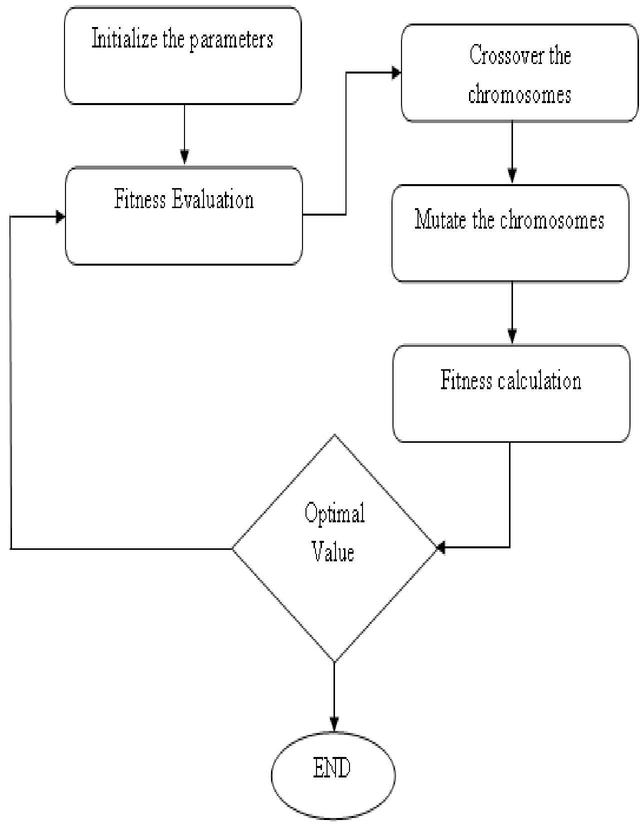


Fig1 Simple Genetic Algorithm

3.2. Adoptive Genetic Algorithm (AGA)

In usual genetic algorithm, the mutation rate or probability is stable for all chromosomes to unearth the fitness function. So there is no altering in any values for the best fitness values for the best chromosomes. The adoptive genetic algorithm is used to tune the value near the best value with the less time. The following flow chart is shown the adoptive genetic algorithm:

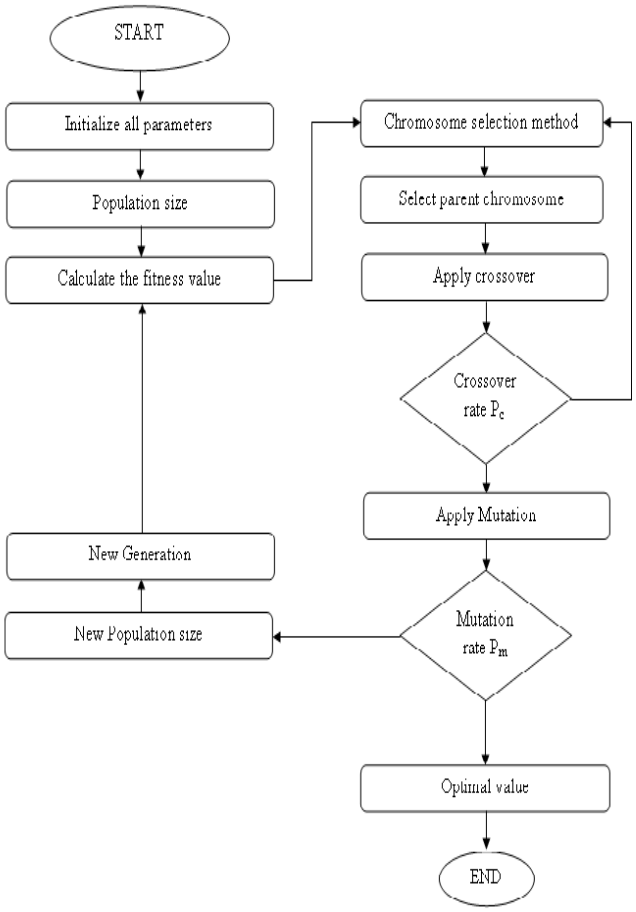


Fig2. Adoptive Genetic Algorithm flowchart

In this paper the following constraints were used
1. Population size: 500
2. Number of generation: 700
3. Crossover rate: 0.4-0.2
4. Mutation rate: 0.6-0.4
5. Punishment values: 1.6-1.5
6. Number of warehouses =7
7. Number of customers = 7

1. Shipping cost between customers and warehouses

	Warehouse(J)							
Customer (I)	**1**	2.9	3.2	3.5	3.14	3.15	3	2.1
	2	3.9	4	4.3	3.62	3.6	4.1	5.8
	3	3.5	3.6	3.5	3.14	3.12	3.6	4.8
	4	3.5	3.6	3.6	3.19	3.17	3.6	4.9
	5	3.3	3.4	3	2.99	3.07	3.4	4.6
	6	3.3	3.4	3.1	3.04	3.13	3.5	4.7
	7	3.1	3.3	3.8	3.31	3.28	3.2	1.8

2. Shipping time between customers and warehouse.

	Warehouse (J)							
Customer (I)	1	4.48	5.83	7.9	7.33	8.08	4.18	2.11
	2	15.91	14.75	12.23	12.21	12.03	15.26	19.23
	3	10.86	9.7	7.33	7.15	6.98	10.21	15.45
	4	11.65	10.48	8.11	7.93	7.76	11	16.23
	5	9.13	7.96	4.85	5.73	6.58	8.58	14.61
	6	9.14	8.25	5.3	6.18	7.11	9.01	15.06
	7	6.48	7.4	9.91	9.33	8.73	6.2	0

Following symbols are defined for the problem under consideration.
V: represents the m customer
U: represents the r warehouse
E: The edges that links with customers with warehouses. For each edge Eij (link warehouse I with customer j)
V_i: Customer request
$q_{j:}$ Warehouse j capacity

The criteria for evaluation depend on two main factors: the shipping cost cij between warehouses I and customer j and the shipping time spent Tij in the process of shipping from warehouses i to the customer j. The two factors are represented in forms of two objective functions to solve the problem of scheduling multiple warehouses as follows

1. An objective function to minimize the shipping cost Cij of request Vi of every customer i(i=1..m), from the warehouse, (j=1..r), that is assigned to him (i.e, the only one link xij that is equal to 1)

$$\text{Minimize } f1(x) = \sum_{i=1}^{m} \sum_{j=1}^{r} v_i c_{ij} x_{ij}$$

2. An objective function to minimize the shipping time Tij of every customer I,(i=1..m), from the warehouse j,(j=1..r) that is assigned to him (i.e the only one link xij that is equal to 1):

$$\text{Minimize } f2(x) = \sum_{i=1}^{m} \sum_{j=1}^{r} {}_{ij} x_{ij}$$

Subject to:

a. Every customer I has been assigned to only one warehouse j

$$\sum_{j=1}^{r} x_{ij=1} \quad , i= 1,2\ldots m$$

$$x_{ij} = \begin{cases} 1 \text{ if customer is allocated to warehouse } j, i=1,2..m, j=1,2..r \\ 0 \text{ otherwise} \end{cases}$$

b. The total demand of all customers Vi, (i=1..m), does not exceed the total capacities of all warehouses

$$\sum_{i=1}^{m r} v_i x_{ij} \le q_i \quad , i=1,2..m$$

Merging the shipping cost and the shipping time objective function yield the following fitness function :

$$f(x) = w1.f1(x) + w2.f2(x)$$

Where w1 is a fixed weight of f1(x), w2 is a fixed weight of f2(x).

The way to determine the values of w1and w2 are computed as follows:

$$w1 = \frac{w1}{w1+w2} \qquad w2 = \frac{w2}{w1+w2}$$

Where *w1 is f'1(x)- f'1,min(x), and w2 is f'2(x)-f'2,min(x)*

The evaluation of the fitness function f(x) is computed as follows:

$$eval(f(x) = w1.f'1(x)+w2.f'2(x),$$

Where $_{f1(x)}$ is the first derivative of $f_1(x)$, and $_{f2(x)}$ is the first derivative of $f_2(x)$,

The first derivative $f_1(x)$ (shipping cost functions) is computed as follows:

$$f1(x) = \frac{f1(x) - f1,min(x)}{f1,max(x) - f1,min(x)}$$

where $f1_{,max}(x)$ is the highest cost value achieved for any chromosome in a generation, and $f1_{,min}(x)$ is the lowest cost value achieved for any chromosome in a generation. The first derivative $f_2(x)$(shipping time function) is computed as follows:

$$f2(x) = \frac{f2(x) - f2,min(x)}{f2,max(x) - f2,min(x)}$$

Where $f2_{,max}(x)$ is the highest time value achieved for any chromosome in a generation, and $f2_{,min}(x)$ is the lowest time value achieved for any chromosome in a generation.

For AGA

1. $Si = [f_{max}-f_{min}/f_{avg}]^{nc}$

2. $N_{mr} = 0.7\{[1+B(f_{max}-f_{min})^{nc}-(f_{avg})^{nc}]Si \; X \; [(f_{max}-f_{min})^{nc}-(f_{avg})^{nc}]\}$

Where Si=Sigma function. Nc &B=Constants

N_{mr} = Adoptive mutation rate

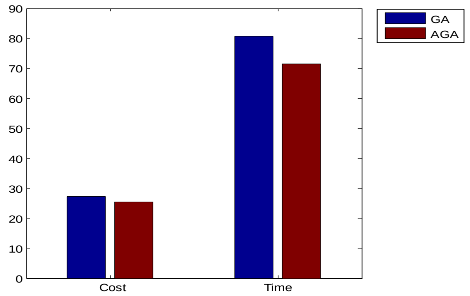
f_{max} = Corresponds maximum fitness value

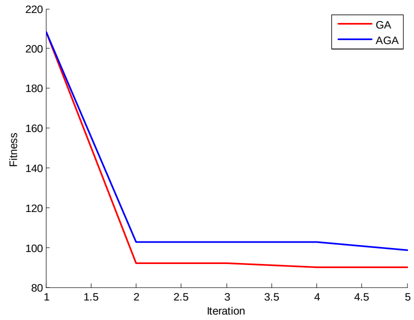
f_{min} = Corresponds minimum fitness value

f_{avg} = Corresponds average fitness value

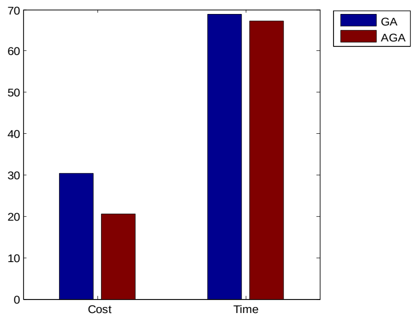
For different number of iterations the Shipping cost and time has been calculated.

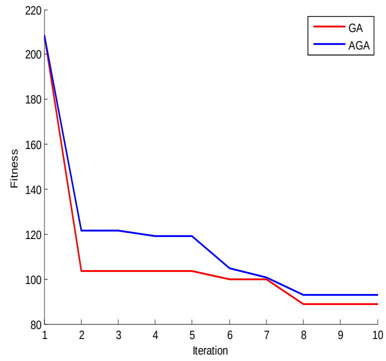
For Iteration value = 5, Enter no of iteration: 5,
Cost of GA: 27.203, Cost of AGA: 25.4237
Time of GA: 80.5652, Time of AGA: 71.4144



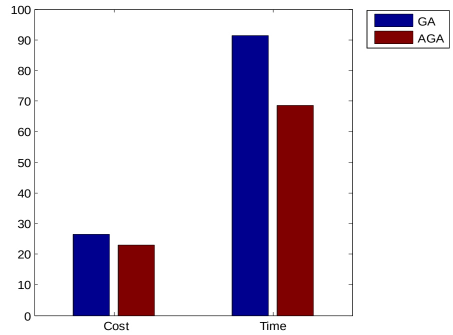


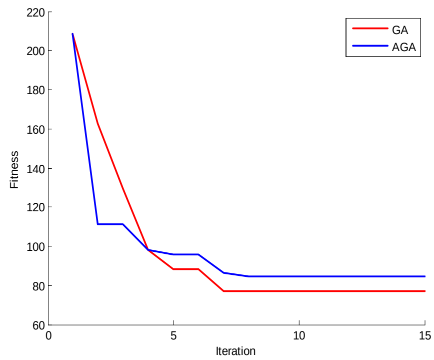
2) For Iteration value = 10, Enter no of iteration: 10
Cost of GA: 30.483, Cost of AGA : 20.5418
Time of GA: 68.8136, Time of AGA : 67.2109



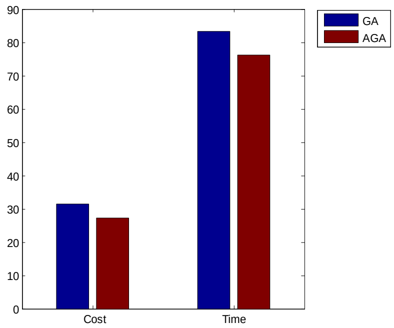


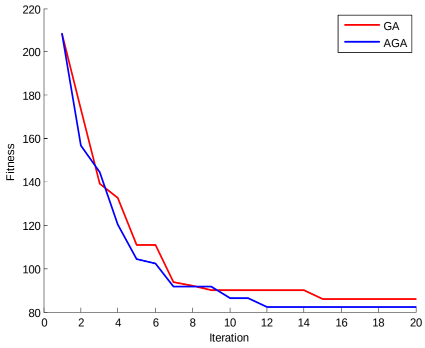
3) For Iteration value = 15, Enter no of iteration: 15
Cost of GA: 26.4096, Cost of AGA: 22.8585
Time of GA: 91.4582, Time of AGA: 68.637





4)For Iteration value = 20, Enter no of iteration : 20
Cost of GA : 31.5403, Cost of AGA : 27.1373
Time of GA : 83.351, Time of AGA : 76.1482





4. CONCLUSIONS

In this work GA and AGA using MATLAB environment are used for optimizing shipping cost and time in a manufacturing industry. The analysis is carried out for 5, 10, 15 and20 iterations. Based on the results, it is concluded that AGA gives lower shipping cost and time as compared to GA.

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BIOGRAPHIES

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