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A Review on Genetic Algorithm for Optimization of Multi Factory, Multiproduct Supply Chain

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Abstract: *In this paper Genetic Algorithm is used to optimize the supply chain cost of multifactory, multiproduct. The most important among a variety of topics that relate to computation are algorithm validation, complexity estimation and optimization.*

Keywords: *Supply chain, Multifactory, Multifactory, Genetic Algorithm and Optimization.*

INTRODUCTION

Managing the entire supply chain becomes a key factor for the successful business. In this work, the optimal solution of a supply chain networking is obtained by using the non-traditional technique such as genetic algorithm. The proposed genetic algorithm frame work offers a number of advantages like it is a multiple point search technique that examines a set of solutions and not just one solution.

Inventory Optimization Analysis Using GA

Supply chain discussed here consists of three stages and six members as shown in Fig.1

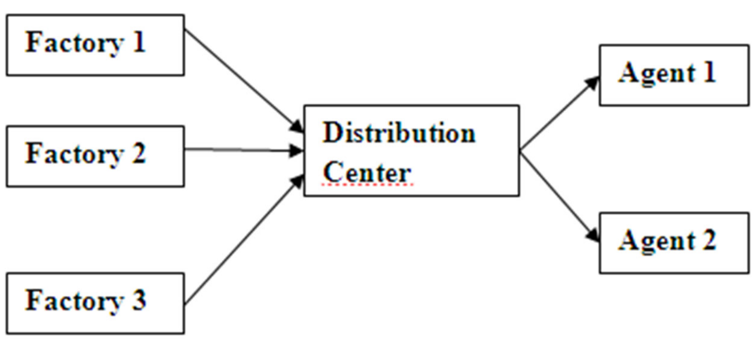

Fig.1: 3 Stage 6 member supply chain

This supply chain has three factories which are the parents of the chain and they are having one distribution center. In this case, the distribution center is having two agents. Now assume that Factory1 manufactures products P1 and P2, Factory2 manufactures products P1, P2 and P3 and Factory3 manufactures products P2 and P3 which would be supplied to the distribution center. From the

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distribution center the stocks will be moved to the agents. Further assumption is made that Agent1 deals with Products P1, P2 and Agent2 deals with Products P2, P3.

GA analysis will determine whether the stock level of the particular product to be maintained by different members of the supplied chain needs to be in abundance or needs be held minimal. The stock levels for the respective products at each member are considered as data set as shown in Table 1.

Table: 1 The data set format for the analysis

Factory1		Factory2			Factory3		Distribution Center			Agent1		Agent2	
P1	P2	P1	P2	P3	P2	P3	P1	P2	P3	P1	P2	P2	P3
100	-20	36	-65	42	25	-170	48	23	-79	100	-200	289	-423

In the valid record set selection, records having nil values are rejected and the values having positive or negative are selected for the analysis which is achieved by using Clustering algorithm, Extraction algorithm or by any of the data mining functions.

Generation of Individuals

Here the chromosome of 14 genes where random values occupy each gene is generated along with the product representation. After the generation of the individuals, the number of occurrences of the individual in the past records is determined. This is performed by the function count ( ) and the total number of occurrences of that individual for that particular product is determined. This is equivalent to the number of occurrences of such situation of stock levels for the respective product in all the members throughout the period under consideration.

Evaluation of Fitness Function

The fitness function is given by,

where,
N_c is the number of occurrences of the chromosome k in record set.
N_{tot} is the total number of inventory values obtained after clustering.
m is the total number of chromosomes for which the fitness function is calculated.

The fitness function mentioned ranks the randomly generated chromosome. Then, the chromosomes are subjected to genetic operations. Genetic operations comprises of selection, crossover and mutation.

Genetic Operators

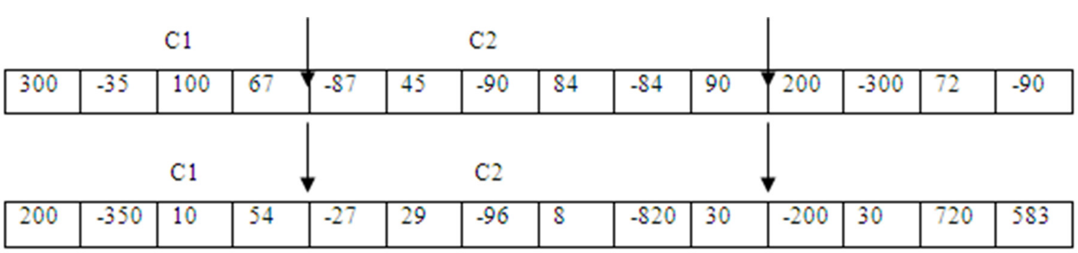
Selection

The fittest chromosome for further genetic operation is found by the selection operation. This operation is the initial genetic operation. This is done by offering ranks based on the calculated fitness function value.

Crossover

The second step of genetic operation is Crossover. In this complex task two point crossover is chosen. From the mating pool two chromosomes are selected for crossover operation. The crossover operation is pictured in Fig. 2.

Before Crossover



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After Crossover

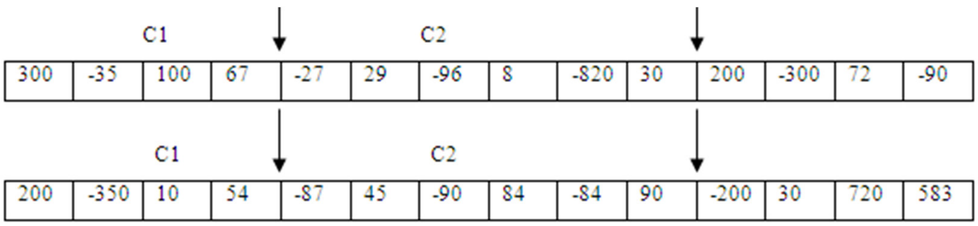
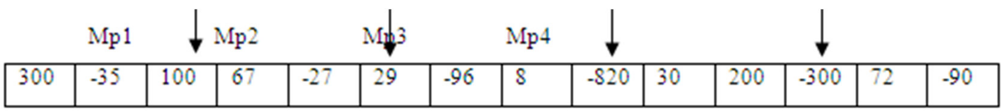


Fig. 2: Chromosome subjected to two point crossover operation

Mutation

The final stage of genetic operation is Mutation. Four mutations Mp1, Mp2, Mp3 and Mp4 points are selected randomly which points any four genes of a particular chromosome as shown in Fig.3. After mutation a new child chromosome is obtained which is fitter than the parent chromosome.

Before Mutation



After Mutation

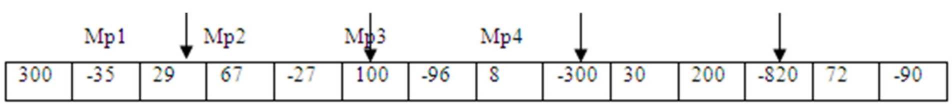


Fig. 3: Chromosome subjected to mutation operation

After obtaining the best chromosome from the 1st iteration, another random chromosome will be generated and these two chromosomes will be used for 2nd iteration. Similarly the process repeats for a particular number of iteration while the two chromosomes that are going to be subjected to the process is decided by the result of fitness function. Each number of iteration will give a best chromosome and this will be considered to find an optimal solution for the inventory control.

Experimental Results

The approach used for optimization of inventory level and thereby efficient supply chain management has been implemented in the platform of MATLAB. A sample database which consists of the past records is shown in Table 2.

Table 2 A sample data set along with its stock levels in each memberof the supply chain

F1 P1	F1 P2	F2 P1	F2 P2	F2 P3	F3 P2	F3 P3	D1 P1	D1 P2	D1 P3	A1 P1	A1 P2	A2 P2	A2 P3
-12	-686	-620	42	-891	-824	941	-32	902	-450	-26	-144	6	238
-407	37	-81	-64	-391	99	-196	-146	-4	443	74	-56	-73	445
-62	-524	-68	-254	205	446	-469	-92	-524	-685	-25	205	46	-46
-84	266	96	65	735	244	-752	-44	-282	57	-926	-414	-200	-743
-49	-282	77	-926	-44	-200	-743	540	-830	-835	82	-39	78	-65
40	-80	-835	82	-39	768	-65	-371	-76	-299	64	448	76	340
-371	-736	-299	634	448	756	340	-778	-313	629	-690	824	-927	850
-78	-313	629	-60	824	-97	850	351	293	328	-732	37	-56	685
500	108	490	-345	-236	108	-931	844	-728	286	740	686	-421	424
-321	2	-450	-260	-14	162	238	775	-394	-520	-72	-927	-89	-50
794	932	-584	307	-171	-529	-503	-122	-686	-620	424	-891	-824	941
-122	-686	-60	424	-891	84	941	235	464	401	108	346	40	-34
235	764	401	108	346	840	-934	218	-848	836	133	-554	-939	-834
489	9	148	50	196	851	-45	-422	638	66	-112	59	107	-40
893	20	-523	-736	-778	63	-335	540	-830	-35	882	-379	768	-635
-778	-313	629	-90	84	-927	80	844	-728	786	40	686	-1	424
-122	-66	-60	424	-891	-824	9	775	-34	-520	-72	-927	-89	-57

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49	409	48	850	196	851	-45	893	520	-423	-736	-78	863	-35
50	108	490	-345	-26	108	-931	540	-30	-835	882	-79	78	-65
-449	-22	577	-926	-44	-200	-743	-371	-76	-299	634	48	756	340

In the database as tabulated in Table 2 the record row are related with stock levels that were held by the respective members of the supply chain network. From the data set two different random chromosomes are subjected to genetic operations. The process is repeated until the best chromosome is obtained.

The final best chromosome obtained from the GA based analysis is shown in Fig. 4.

200	-350	10	66	-120	46	-9	40	-8	20	156	-30	48	10

Fig. 4: The final best chromosome obtained from the analysis

The above chromosome is responsible for the maximum increase of the supply chain cost. By focusing on the excess/shortage inventory levels and initiating the appropriate steps to eliminate the same at each member of the chain, the supply chain cost can be minimized. Thus by following the predicted stock levels, the increase of supply chain cost can be avoided.

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