An Algorithmic Approach for Optimizing Inventory Management

Bindhya Thomas

Lecturer, AMAIUB

Abstract-In the management of Inventory in a supply chain, stock management plays a very important role. The stock level plays a crucial role in any supply chain management. There is a element of uncertainty in the process. The uncertainty can affect the performance level of the business.

The under or over stocking of inventory adversely affects a business. In this work Genetic algorithm is proposed which tries to find out the optimal holding of stock. This algorithm uses a multiple set of crossover operators and mutation operators for solving the problem. In this work we try to iterate input uncertain data and compute robust solutions for inventory management in a supply chain.

I. INTRODUCTION

A supply chain, from an operations perspective, has three components: sourcing or procurement, manufacturing and distribution, and inventory disposal. The focus of this paper is on decision making in the sourcing component. In particular, we develop a genetic procedure for determiningoptimal setting for controllable inputs.

Whereas manufacturing and inventory disposal decisions might be internal to a company most of the time and therefore easier to change or modify, sourcing decisions that include outside companies will be hard to change due to contracts and agreements.

Supply chain problems are often very large and complex owing to the interactions between the entities, the length of the supply chain, the lead times of manufacturing and shipping, the complexities of modeling the individual entities, the stochastic nature of the demands, etc. Because of these complexities, very few analytical models exist except for simplified versions of the problem which often are based on limiting assumptions.

Even if the analytical forms do exist, it is very difficult to solve these models using traditional search methods like linear programming, differentiation, or even local gradient based methods owing to the fact that most of the models are discrete, non-linear and/or multi-modal. Therefore, heuristic or computational methods are required to even determine good solutions.

II. GENETIC ALGORITHM USING MULTIPLE CROSSOVER AND MUTATION OPERATORS

In building a GA methodology to solve the supply chain sourcing problem, six fundamental issues that affect the performance of the GA must be addressed: chromosome representation, initialization of the population, selection strategy, genetic operators, termination criteria, and evaluation measures. In the following subsections, these issues are introduced and described specifically for the proposed multi-objective GA.

Chromosome Representation For any GA, a chromosome representation is needed to describe each individual in the population. Chromosome representation determines how the problem is structured in the GA, as well as the genetic operators that can be used. For the sourcing decision, the chromosome representation in this case is fairly straightforward. Notice, that not all combinations of the decision variables constitute a feasible solution.

Initialization of the Population The initial population is formed randomly based on the upper and lower bound for each of the decision variables in a chromosome using a uniform distribution.

Selection Strategy Selection of parents to produce successive generations is very important in driving the search. The goal is to give more chance to the “fittest” individuals to be selected. For each selection scheme, probabilities are assigned to the individuals. The better individuals have higher probabilities. A normalized

III. UNCERTAIN DATA MANAGEMENTUSING GENETIC ALGORITHM

Genetic algorithms can produce good balance between their precision and their complexity. Systems use genetic algorithms for providing learning and adaptation capabilities fr.om uncertain data set. A set of techniques disclosed here, can be used to enhance searching and retrieving information from an existing fuzzy Knowledge Base (KB),

The proposed genetic algorithm tries to be capable of generating solutions from both crisp and fuzzy valued data. The search algorithm transforms vague and uncertain data represented as fuzzy sets for accurate solution generation.

Procedures are proposed which learns from the different available knowledge base for its application on uncertain data. In this Work, a repeat crossover Genetic Algorithm is formulatedfor its usage on uncertain data represented as fuzzy sets and it can be implemented for many real world applications.

In most real-world problems, data have a certain degree of imprecision. Sometimes, this imprecision is small enough [5]so that it can be safely ignored. On other occasions, the uncertainty of the data can be modeled by a probability distribution (e.g., additive random noise).

Lastly, there is a third kind of problems where the imprecision is significant, and a probability distribution is not a natural model. For example, in [5], up to eight sources of information appropriately characterized by intervals were studied: plus-or-minus reports, significant digits,intermittent measurement, non-detects, censoring, data binning, missing data and gross ignorance.

As a further matter, there are ongoing researches about the use of Genetic Algorithm (GA) for modeling the interaction between variability and imprecision.

The use of GA is to learn and evaluate Genetic Systems, and to advocate the use of specific reasoning methods and search functions to solve problems of uncertainty.

In this work a comprehensive algorithm is proposed in order to learn from an existing Knowledge Base (KB) of imprecise data. The description includes some issues about the reasoning methods suitable for using vague data. bounds of the accuracy of a KB on vague data,and multi criteria genetic algorithms capable of optimizing a mix of crisp and fuzzy objectives.

IV. PROPOSED WORK

The Proposed work considers the uncertainty in occurrence of data in many applications. It develops a Multicriteria Repeat Crossover algorithm for managing Uncertain Data.

Proposed Multicriteria Repeat Crossover Genetic Algorithm (MRCGA):

Step 1. (Initialization)

Choose population size *N* based on multi criteria (Crispy and Fuzzy Input data), proper crossover probability c *p* and mutation probability *m p*,

After obtaining the new chromosome, another random chromosome will be generated. Then again the process repeats for a particular number of iteration while the two chromosomes that are going to be subjected for the process is decided by the result of the 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. When the number of iterations is increased then the obtained solution moves very closer to the accurate solution.

More the number of iterations results in more accurate optimal solution. Eventually with the help of the Genetic algorithm, the best stock level to be maintained in the members of the supply chain could be predicted from the past records and so that the loss due to the holding of excess stock level and shortage level can be reduced in the upcoming days.

S.No	Production center	Supplier 1	Supplier 2
1	-591	-329	269
2	-479	-796	-548
3	-591	-329	269
4	494	392	285
5	-591	-329	269
6	372	573	-345
7	999	-934	108
8	146	118	532
9	-591	-329	269
10	-591	-329	269

Table 1 A sample of data sets having stock levels

V. CONCLUSION AND FUTURE RESEARCH

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 for the three different members of the supply chain, Production Center, Supplier1 and Supplier 2 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 is given in table 9.1. Some 10 sets of data are given in the table .1 and these are assumed as the records of the past period. The two initial chromosomes are generated at the beginning of the genetic algorithm.

These initial Chromosomes are subjected for the genetic operators, Crossover and Mutation. Theresultant chromosome thus obtained is once again processed with repeat crossover and mutation so that it moves towards the best chromosome after the each iterative execution: Hence at the end of the execution of 'n' iterations, best chromosome '-591 -329 269' is obtained.

While applying 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 obtains a stock level that is a better prediction for the inventory optimization in supply chain management.

When the data is imperfect and uncertain, an algorithm to manage such data is proposed. This algorithm tries to repeatedly crossover and mutates the uncertain data in

inventory tock management .This leads to better solutions in much iteration.

The algorithm proposed here helps in arriving at solutions which can process uncertain data. This algorithm can be implemented in uncertain data based applications which have both crisp and fuzzy data inputs. Better insight gained by this technique will help to harness its power for various applications. In future research, the algorithm can be improved in the areas of speed, accuracy and consistency over a larger uncertain input data environment.

REFERENCES

[1] Kaur Arshinder, Arun Kanda, and S.G. Deshmukh ,2008,"A Review on Supply Chain Coordination: Coordination Mechanisms, Managing Uncertainty and Research Directions".Springer-Verlag.

[2] Miguel Zamarripa, Javier Silvente and Antonio Espuña, 2012,"Supply Chain Planning under uncertainty using Genetic Algorithms" .J.Computer Aided Chemical Engineering, Vol.30, pp.457-461

[3] Chandrasekaran Sowmya Danalakshmi, Gabriel Mohan Kumar,2008."Optimization of Supply Chain Network Using Genetic Algorithm",

[4] Zheng yahong,2012," Supply Chain Management under availability & uncertainty", Doctoral Thesis submitted to Laboratoire d'Automatique, Genie Informatique et Signal (LAGIS),France.

[5] Patcharee Boonyathan , Damien Power, 2007,"Impact of Supply Chain Uncertainty on Business Performance and the Role of Supplier and Customer Relationships: Comparison between Product and Service Organization" ,University of Melbourne.

[6] C.N. Verdouw1,2, A.J.M. Beulens2,2011,"Agile Information Systems for Mastering Supply Chain Uncertainty", Handbook- Supply Chain Management - New Perspectives.

[7] Yufu Ning, Huanbin Sha, Lixia Rong,2012,"Two-stage Supply Chain Model with Uncertain Demand", Proceedings of the Twelfth International Conference on Electronic Business, Xi'an, China.

[8] Rachel,Denis,1998,"Shrinking the supply chain uncertainty circle", IOM control.

[9] Rachel Mason-Jones, and Denis R. Towill ,2000,"Coping with Uncertainty:Reducing "Bullwhip" Behaviour in Global Supply Chains" Supply Chain Forum An International Journal N°1.

[10] J. Mula!, R. Poler, J.P. Garcıa Sabater, F.C. Lario,2006, Models for production planning under uncertainty: A review", International Journal of Production Economics Volume 103, Issue 1, September 2006, Pages 271–285.

[11] Jack G.A.J. van der Vorst, 2002,"Identifying sources of uncertainty to generate supply chain redesign strategies, International Journal of Physical Distribution & Logistics Management.

[12] Jorge Casillas a, Francisco J. Martı´nez-Lo´pez ,2009,"Mining uncertain data with multiobjective genetic fuzzy systems to be applied in consumer behaviour modelling". Expert Syst. Appl. 36(2): 1645-1659.

[13] Luciano Sáncheza, InésCousob, JorgeCasillas,2009,"Genetic learning of fuzzy rules based on low quality data", Fuzzy Sets and Systems 160(17): 2524-2552 .

[14] Lawrence V. Snyder ,2006,"Supply and Demand Uncertainty in Multi-Echelon Supply Chains", Lehigh University.

[15] Martin Christopher,2012,"Managing Supply Chain Complexity in an Age of Uncertainty", Lecture Notes,Cranfield University,U.K.

[16] Fatemeh Forouzanfar and Reza Tavakkoli-Moghaddam ,2012,"Using a genetic algorithm to optimize the total cost for a location-routing-inventory problem in a supply chain with risk pooling", Journal of Applied Operational Research.

[17] Kumaraguru Mahadevan,2007,"Supply Chain Uncertainty: An insight for Australian CEO's and Managers". Proceedings of 8th International Research Conference onQuality, Innovation and Knowledge Management.

[18] Jyri Vilko*, Jan Edelmann, Jukka Hallikas,2012,"Defining the levels of uncertainty in supply chains Jyri Vilko*, Jan Edelmann, Jukka Hallikas,Research paper, Lappeenranta University of Technology,Finland.