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APPLYING FUZZY GENETIC ALGORITHMS TO SOLVE A FUZZY INVENTORY WITH BACKORDER PROBLEM

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Abstract. *In this paper, we present a fuzzy inventory problem and apply genetic algorithm to solve it. We derive the cost function in the fuzzy sense, and find the nearly optimal solution by genetic algorithm.*
Keywords: Fuzzy set, Membership function, Genetic algorithms, Fuzzy inventory

1. **Introduction.** In the previous decade, a series of papers by Yao and other authors [2,4,7,12,13] discussed the inventory problems with or without backorder in the fuzzy sense. They applied the extension principle to derive the membership function and defuzzified it using the centroid method to obtain the optimal solution in the fuzzy sense. From past experience, deriving the membership function is a very tedious and difficult task. For a known fuzzy case, the decision maker can obtain the corresponding value from the centroid (cost estimate) and get the order quantity (estimate). Many uncertainties, however, arise in the fuzzy circumstances; thus, the decision maker can only wish to consider an optimal solution in the fuzzy sense. In such circumstances, how to avoid deriving a complex membership function becomes an important issue. Therefore, in this study we consider the application of genetic algorithm (GA [1,5,6,8]) to find the near-optimal solution in the fuzzy sense. GA has been successfully applied to many hard problems, e.g., [3] to find nearly optimal image authentication problem [9] and to solve linear programming.

In Section 2, we state that in [12], the authors consider an inventory backorder model for which the total cost function is $F(q,s) = \frac{aTs^2}{2q} + \frac{bT(q-s)^2}{2q} + \frac{cr}{q}, 0 < s < q$, where q is the order quantity and s is the maximal stock quantity. Let $G_s(q) = F(q,s)$. The process of reaching the optimal function includes a number of stages: we fuzzify q as a triangular fuzzy number $\widetilde{q}$ and treat s as a real variable; we then get the fuzzy total cost $G_s(\widetilde{q})$; then through the extension principle, we derive a complex membership function $\mu_{G_s(\widetilde{q})}(y)$ and centroid and obtain the optimal solution in the fuzzy sense. It is a tedious and difficult job. Moreover, even if we do not find the membership function, we can get a near-optimal solution in the fuzzy sense by using GA. The GA is depicted as follows:

We change $q > 0$ to $0 < q \le kq^*$ (for the reason, please see Properties 3.1, 3.2 and Remark 3.1) where q^* is the crisp optimal order quantity and $K > 1$ is an appropriate natural number. Let $\widetilde{Q}$ be an arbitrary fuzzy set defined on the interval $(0, kq^*]$. Since, for each q, $0 < s < q$, $s = \frac{bq}{a+b}[= s(q), say]$ then $G_s(Q)$ is a minimum value. Therefore, with $G^*(q) = G_s(q)$, we get the fuzzy total cost $G^*(\widetilde{Q})$. We divide the interval $(0, kq^*]$ into M equal partitions. $q_j = j\frac{kq^*}{M}, j = 1, 2, \cdots, M$, q_j is called the j^{th} partition point. Apply the