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STUDY OF SOME SINGLE AND MULTIOBJECTIVE STOCHASTIC INVENTORY MODELS IN FUZZY OPTIMIZATION TECHNIQUE

Anant Tiwari[1], Dr. Amit Kumar Vats[2]
[1]Research Scholar, School of Applied and Social Sciences, Singhania University, Pacheri Bari, Jhunjhunu, Rajasthan, India
[2]Assistant Professor, School of Applied & Social Sciences, Singhania University, Pacheri Bari, Jhunjhunu, Rajasthan, India

Abstract
In this paper we present a Fuzzy stochastic inventory models. In a stochastic programming problem, the vulnerabilities in the boundaries are addressed by likelihood disseminations. The inventory control utilizing the fuzzy set theory has particular preferences in lessening the quantity of set-ups and stock-outs. To accomplish a few clashing objectives all the while subject to a system of limitations (requirements), in some cases, the objective objectives are not expressed obviously for example they are uncertain in nature. As a single objective stochastic inventory model where the lead-time request follows typical dispersion and with fluctuating deficient rate, expected yearly cost is likewise estimated. In span math technique the stretch objective capacity has been changed into a comparable deterministic multi-objective problem characterized by the left and right constraints of the span. Fuzzy set theory assists with considering fuzzy inventory models since it has a capacity to measure vagueness and imprecision without utilizing arbitrariness.
Keywords: fuzzy, inventory, model, single, multi-objective, stochastic, etc.

1. INTRODUCTION

Inventory alludes to any sort of conservative esteemed asset that is kept up to satisfy the present and future prerequisites of an association. It could be perceived that different costs are spent by an association to keep an alluring degree of inventory are called significant costs. A decent association consistently plans to limit the amount of all spending costs, that is, the all out inventory cost. Intuitionistic Fuzzy Set (IFS) was acquainted by Atanassov and appears with be appropriate to true problems. The idea of IFS can be seen as an elective approach to characterize a fuzzy set in the event that where accessible data isn't adequate for the meaning of a loose idea by methods for an ordinary fuzzy set. Accordingly it is normal that IFS can be utilized to reenact the human decision-making measure and any exercises requiring human skill and information that are unavoidably uncertain or absolutely solid. Here the levels of dismissal and fulfillment are considered so the amount of the two qualities is in every case not as much as solidarity.

An inventory control strategy manages the idea of relative boundaries, for example, disintegration rate, demand, holding cost, shortage cost and so forth Demand is the critical factor of inventory the board. Such countless analysts have utilized various kinds of demands, for example, consistent, value dependent, stock dependent, time dependent, outstanding, incline type and so on In old style inventory models for the most part demand is thought to be steady however, in actuality, circumstances it happens seldom. In the greater part of the current inventory models, it is accepted that the inventory boundaries, objective objectives and requirement objectives are deterministic and fixed. Be that as it may, on the off chance that we think about their useful importance, they are questionable, either random or uncertain. At the point when a few or all boundaries of an optimization problem are portrayed by random variables, the problem is known as a stochastic or probabilistic programming problem. In a stochastic programming problem, the vulnerabilities in the boundaries are addressed by likelihood disseminations. This dissemination is assessed based on the accessible noticed random information. Here, the boundaries are treated as random variables. For arrangement, the stochastic problem is first diminished to a fresh one and afterward tackled by an optimization technique.

1.1 Fuzzy inventory models

Numerous decision-making problems, in actuality, circumstances are too intricate to ever be seen quantitatively since the unpredictability by and large emerges from vulnerability as vagueness. The likelihood theory has been a viable instrument to deal with vulnerability, yet it very well may be applied uniquely to take care of the problems whose qualities depend on random cycles. In 1965, Zadeh presented the fuzzy set theory as an expansion of traditional set theory. Fuzzy set theory assumes a significant part in settling inventory control models in vulnerability. An inventory model having in any event one fuzzy boundary is known as a fuzzy inventory model. The fuzzy inventory model gives preferable and satisfactory derivations over the fresh inventory model for their dubious information. On account of this explanation, numerous specialists have pulled in to work and to offer more for its turn of events. The inventory control utilizing the fuzzy set theory has unmistakable points of interest in decreasing the quantity of set-ups and stock-outs. In the fuzzy climate, the inventory model was started by Lee and Yao.

2. MATHEMATICAL MODELS

We consider a multi-thing single-period inventory problem with budgetary and floor or rack space imperatives. We expect that the demand of the things follows likelihood appropriation so n items are stocked to fulfill a random outside demand during a single period. For everything, a request amount Qi can be made for conveyance preceding the start of the period. No resulting requests can be made during the period. Abundance demand is discarded at a lower cost. We consider additionally inventory-conveying cost for things sold during the period and those excess toward the end. This cost depends on the normal inventory as opposed to just consummation inventory as is for the most part accepted, under the accompanying suppositions:

2.1 Fuzzy Multi-Objective Stochastic Inventory Model (FMOSIM)

To accomplish a few clashing objectives all the while subject to a system of limitations (imperatives), now and again, the objective objectives are not expressed obviously for example they are uncertain in nature. At that point, fuzzification of the MOSIM is required. Subsequently, when both the greatest absolute income acquires just as least all out inventory related cost is uncertain in nature, model can be reformulated as:

$$\mathrm{Ma\tilde{x}}\ RS(Q1, Q2, \ldots\ldots, Qn) = \sum_{i=1}^{n}((si \int_0^{Qi} xfi(x)dx + siQi \int_{Qi}^{\infty} fi(x)dx + Li \int_0^{Qi} (Qi - x)fi(x)dx)$$

$$\mathrm{Mi\tilde{n}}\ IC(Q1, Q2, \ldots\ldots, Qn) = \sum_{i=1}^{n}((piQi + \frac{C1iQi}{2} + \frac{C1i}{2}\int_0^{Qi}(Qi - x)fi(x)dx + C3i\int_{Qi}^{\infty}(x - Qi)fi(x)dx))$$

Subject to

$$\sum_{i-1}^{n} fiQi \leq F$$

$$\sum_{i-1}^{n} piQi \leq B$$

$$Qi \geq 0\ (i = 1, 2, \ldots, n)\ (1)$$

Where, For i-th item (i=1, 2, … .., n), pi = buying cost of every item, s_i = selling cost of every item, C_{1i} = inventory conveying cost per amount per unit time, C_{3i} = shortage cost for unsatisfied demand, L_i = rescue esteem per unit, f_i = floor space accessible per unit, D_i = demand of the i^{th} item. F = floor space accessible, B= spending plan accessible for renewal. Here wavy bar '~' designates "fuzzification" of the parameters.

2.2 Single Objective Stochastic Inventory Model (SOSIM)

Hence a quality-changed lot-sizing model is framed as

MinEC(Q, s)= Setup cost+ non-defective item holding cost+ stockout cost+ defective item holding cost+ inspecting cost

$$= \frac{DK}{Q(1-\theta)} + h(s - \mu + \frac{1}{2}(Q(1-\theta) + \theta)\ (2)$$

$$+ \frac{D\pi\overline{(s)}}{Q(1-\theta)} + h'\theta(Q - 1) + \frac{Dv}{1-\theta'}, Q,s>0$$

It is the stochastic model, which limits the normal yearly cost.

3. FUZZY-STOCHASTIC INVENTORY MODEL

Allow decay to rate is fuzzy, for example its worth is about (i.e.,θ_i) and addressed by a trapezoidal fuzzy number. Let $\tilde{\theta}i$ = (θ_{il}, θ_{i2}, θ_{i3}, θ_{i4}). Its pictorial portrayal is portrayed in Figure-I. It implies that in the middle θ_{i2} and θ_{i3}, enrollment estimation of crumbling rate is 1 and outside this reach, it is under 1. All the more elaborately, the disintegration rate is regularly inside (θ_{i2}, θ_{i3}). It might likewise be inside (θ_{i1}, θ_{i2}) and (θ_{i3}, θ_{i4}) and the level of belongingness to these qualities is addressed by enrollment capacities (MFs).

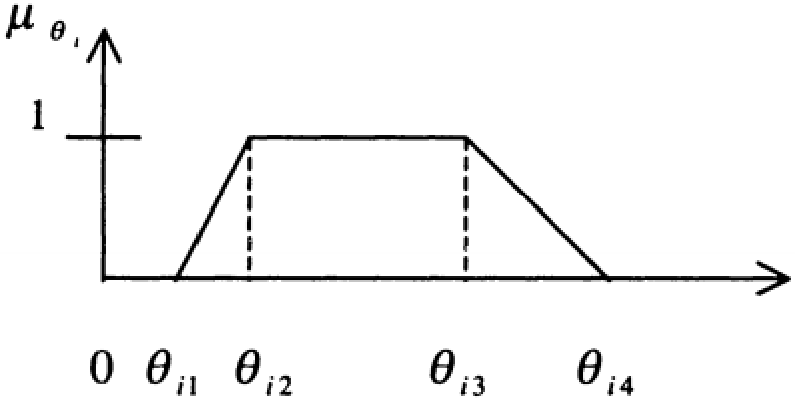

Figure 1: Fuzzy Number $\tilde{\theta}$i in Trapezoidal

Consequently the amounts Q_{ij}, H_{ij} and G_{ij} individually becomes fuzzy and the comparing fuzzy model is

$$\max PF\,(Qij)=\sum_{i=1}^{n0}\sum_{j=1}^{n}(mi\hat{p}i\left(\tilde{Q}ij-\tilde{G}ij\right)-\hat{p}i\tilde{Q}ij-\tilde{H}ij\text{-}(u0i+u1i\tilde{Q}ij))$$
$$=\sum_{i=1}^{n0}\{\tilde{A}ipi-\tilde{B}i\}\ (3)$$

Where

$$\tilde{A}i=\sum_{j=1}^{n}\{mi-1)\widetilde{Qij}\text{-}mi\tilde{G}ij)$$

And

$$\tilde{B}i=\sum_{j=1}^{n}\{\tilde{H}ij+(u0i+u1i\tilde{Q}ij)\}$$

Where wavy bar (~) demonstrates fuzzy portrayal.

4. MULTI-OBJECTIVE PROBLEMS WITH INTERVAL ARITHMETIC TECHNIQUE

In interval arithmetic technique the interval objective capacity has been changed into an identical deterministic multi-objective problem characterized by the left and right constraints of the interval. Using closest interval estimate for the fuzzy numbers, the multi-objective inventory problem is given by

$$\text{Minimize } [TC_L, TC_R]$$
$$=\sum_{i=1}^{n}\{\frac{\theta i}{12Di}Qi^2[\frac{C1i1+C1i2}{2},\frac{C1i2+C1i3}{3}]+\frac{Qi}{2}\left(\frac{C1i1+c1i2}{2},\frac{C1i1+c1i3}{2}\right)+pi\theta i$$
$$+\left(\frac{Di}{Qi}+\frac{\theta i}{2}\right)\left[\frac{C3i1+C3i2}{2},\frac{C3i2+C3i3}{2}\right]\}$$

Subject to

$$\sum_{i=1}^{n}wiQi\le\left[\frac{W1+W2}{2},\frac{W2+W3}{2}\right]$$
$$\sum_{i=1}^{n}piQi\le\left[\frac{F1+F2}{2},\frac{F2+F3}{2}\right]$$
$$(4)$$

Here a triangular fuzzy number $\tilde{A}$= (A^1; A^2; A^3) has been approximated by the interval

$$\left[\frac{A1+A2}{2},\frac{A2+A3}{2}\right]$$

This detailing relates to the articulation with α = 0.5 in Primal-Dual portrayal of the model.

5. FUZZY COST COMPONENTS WITH SINGLE AND MULTIOBJECTIVE STOCHASTIC INVENTORY MODELS

In regular inventory models, vulnerabilities are treated as randomness and are handled by hitting home with likelihood theory. Nonetheless, in specific circumstances vulnerabilities are because of fluffiness and in these cases the fuzzy set theory, initially presented by Zadeh, is relevant. Today the vast majority of these present reality decision-making problems in financial, specialized and ecological ones are multidimensional and multi-objective. It is important to understand that multiple-objectives are frequently non-commensurable and strife with one another in optimization problem. An objective within accurate objective worth is named as fuzzy objective. So a multi-objective model with fuzzy objectives is more practical than deterministic of it.

Intuitionistic Fuzzy Set (IFS) was acquainted by Atanassov and appears with be material to certifiable problems. The idea of IFS can be seen as an elective approach to characterize a fuzzy set in the event that where accessible data isn't adequate for the meaning of a loose idea by methods for an ordinary fuzzy set. In this way it is normal that IFS can be utilized to recreate human decision-making measure and any exercises requiring human skill and information that are unavoidably loose or absolutely dependable. Here the levels of dismissal and fulfillment are considered so the amount of the two qualities is in every case not as much as solidarity.

5.1 Fuzzy Cost Components with Multi-item Stochastic Model

Stochastic nonlinear programming problem with fuzzy cost components considers as

$$\mathrm{Min}EC(Q1,\ldots,Qn,s1,\ldots sn)$$
$$=\sum_{i=1}^{n}\left(\frac{Di\tilde{K}i}{Qi(1-\theta i)}+\tilde{h}i\left(si-\mu i+\frac{1}{2}(Qi(1-\theta i)+\theta i\right)+\frac{Di\tilde{\pi}i\overline{b\imath(s)}}{Qi(1-\theta i)}+\tilde{h}i'\theta i(Qi-1)+\frac{Divi}{1-\theta i}\right)$$
$$Qi,\ si > 0\ \forall i= 1, 2, \ldots, n \quad (5)$$

Here $\tilde{K}i$, $\tilde{\pi}i$, $\tilde{h}i$, $\tilde{h}'i$ address vector of fuzzy parameters engaged with the objective capacity EC. We expect $\tilde{K}i = (K_i^-, K_i^0, K_i^+)$, $\tilde{\pi}i= (\pi^-_i, \pi^0_i, \pi_i^+)$, $\tilde{h}i= (h^-_i, h^0_i, h_i^+)$, and $\tilde{h}'i= (h_i'^-, h_i'^0, h_i'^+)$, all of which are three-sided fuzzy numbers.

5.2 fuzzy cost components with stochastic models

Stochastic non- linear programming problem with fuzzy objective coefficient considers as

$$\mathrm{Min}Z=\tilde{\tilde{C}}X,\ X\geq 0(6)$$

Here $\tilde{C}$ represents a vector of fuzzy parameters involved in the objective function Z. We assume $\tilde{C}i= (c_i^-, c_i^0, c_i^+)$, which is a three-sided fuzzy number with membership function:

$$\mu\tilde{C}_i(t)=\begin{cases}\frac{t-c-i}{ci0-ci-}\text{for } ci-\leq t\leq ci0,\\ \frac{ci+-t}{ci+\_ci0}\text{for } ci0\leq t\ll ci+,\\ 0 \text{ for } t > ci+ \text{ or } t < ci-\end{cases}\ (7)$$

So (7) becomes

$$\mathrm{Min}\ Z= (c_i^-X, c_i^0 X, c^{i+}X),\ X\geq 0\ (8)$$

Where,

$$c^-=(c_1^-,c_2^-,\ldots,c_n^-)$$
$$c^0=(c_1^0,c_2^0,\ldots,c_n^0)$$
$$c^+=(c_1^+,c_2^+,\ldots,c_n^+)\ (9)$$

As per consolidating three objectives into a single objective function, (8) can be decreased to a LPP by probably standards as

$$\mathrm{Min}\left(\frac{(c\mp 4c0+c+}{6}\right)X,\ X\geq 0\ (10)$$

6. CONCLUSION

As of late, inventory models in fuzzy climate have gotten a lot of consideration as a result of giving more helpful data and handling the vulnerability. Fuzzy set theory assists with contemplating fuzzy inventory models since it has a capacity to evaluate vagueness and imprecision without using randomness. As a single objective stochastic inventory model where the lead-time demand follows ordinary appropriation, and with differing defective rate, expected yearly cost is estimated a multi-item single period inventory problem with budgetary and floor space requirement where the demand of the items follows uniform conveyance. It is considered as a multi-objective stochastic inventory model where absolute income procure from deals is amplified just as all out inventory related cost is limited and is additionally figured in fuzzy climate presenting fluffiness in the objectives.

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