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INTRODUCTION OF MONTE CARLO METHOD TO SOLUTION OF FUZZY OPTIMIZATION PROBLEMS: A SURVEY

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Abstract-*In this article we convince that Monte Carlo methods can be useful in generating approximate solutions to fuzzy optimization problems. In a Monte Carlo procedure we randomly produce N feasible solutions to an optimization problem, subject to some criteria we keep only the best feasible solutions and as N grows larger and larger we converge to an optimal solution. Monte Carlo methods are known to be very inefficient and are seldom used in crisp optimization problems since these problems usually have their own efficient solution algorithms. However fuzzy optimization problems usually do not have their own efficient solution algorithms so Monte Carlo method becomes more important in fuzzy optimization.*

Key words: Monte Carlo method, fuzzy optimization problem, feasible solution, algorithm.

I. INTRODUCTION

About Fuzzy Sets and Fuzzy Logic**:**First we need to be familiar with fuzzy sets. For beginning introduction to fuzzy sets and fuzzy logic we see [13]. Three other items related to fuzzy sets, needed in this research are

1. How we have dealt in the past with determining $max/min(\bar{z})$ for $\bar{Z}$ a fuzzy set representing the value of an objective function in a fuzzy optimization problem [10], [13].
2. We present the three methods:Buckley's Method [22], [23];Kerre's Method [35] and Chen's Method [27]. We will use in fuzzy Monte Carlo studies to determine which of the possibilities $\overline{M} < \overline{N}, \overline{M} > \overline{N}$ or $\overline{M} \approx \overline{N}$ is true, for two fuzzy numbers $\overline{M}$and $\overline{N}$, viz. [10],[27],[35].We investigate dominated and undominated, fuzzy vectors [10],[50].

Random Fuzzy Numbers:

Mathematica has added random fuzzy numbers. It can create randomtrapezoidal, Gaussian and triangular fuzzy numbers. We would need the functional expressions for the sides of the fuzzy numbers and it is not clear how we could get that information from Mathematica [52]. So we need a method of getting sequences of Crisp vectors $v = (x_1, x_2, x_3, - - -, x_n)$ $with$ $x_i \in [0,1], n \geq 3;$ that will uniformly fill $[0,1]^n$, known as quasi random number generators [32], [41]. We are particularly interested in Sobol-quasi random integers (sequences) because Sobol sequences are reasonably well known and we have used them with MATLAB [39].

Next we need to randomly generate sequences of fuzzy numbers and sequences of fuzzy vectors we usually use triangular fuzzy numbers (TFNs) and quadratic fuzzy numbers [10]. The quadratic fuzzy numbers we use are called quadratic Bezier generated fuzzy numbers (QBGFNs) [10].

Tests for Randomness:

There are many tests for randomness for sequences of crisp numbers, but most are not applicable to fuzzy numbers. We identified two types of triangular shaped fuzzy numbers: (1) quadratic fuzzy numbers and (2) quadratic Bezier generated fuzzy numbers (QBGFNs). A run test depends on what definition of $\leq$ between fuzzy numbers we are using. So we do the run test three times on the Bezier fuzzy numbers: first using Buckley's method of $\leq$ next using Keree's Method of $\leq$ and lastly using Chen's Method of $\leq$ [10].

Applications of Fuzzy Monte Carlo Method:

Applications of Monte Carlo Methods to generating approximate solutions to fuzzy optimization problems [10], [14]. Approximate solutions to this fuzzy linear program are the fuzzy numbers determined by this Monte Carlo Method. By comparing fuzzy Monte Carlo solutions with Crisp solution that we have a solution consistent with the Crisp solution. Additional compared with an evolutionary algorithm solution, the fuzzy Monte Carlo solution finds a greater fuzzy maximum[9], [10], [12], [14], [19].

Also we compare our Monte Carlo solution using Sobol Quasi random numbers and Chen's Method with evolutionary algorithm solution using Chen's method from [9], [10] and find the min $\bar{Z}$from our Monte Carlo solution is less than the mean min $\bar{Z}$from the evolutionary algorithm solution. Also we compare Kerre's method results and Chen's method results to find the min $\bar{Z}$ from Chen's Method is less than the min $\bar{Z}$ from Kerre's Method solution[9], [10], [12], [14], [19].

We see by comparing these fuzzy [10] Monte Carlo solutions with a Crisp solution that we have a solution consistent with the Crisp solution.

For solving fuzzy linear equations or fuzzy quadratic equations [10] we used fuzzy Monte Carlo optimization to produce some solution. In those examples a classical solution existed found to be acceptable solution by fuzzy Monte Carlo method. And in case no classical solution existed, Fuzzy Monte Carlo determined an acceptable approximate solution.
Though many crisp (non-fuzzy) optimization problems have algorithms to determine solutions [45]; but this is not true for fuzzy optimization.

Application of Monte Carlo Method to be completed in the following Problems:

There are many fuzzy optimization problems we have not yet applied our fuzzy Monte Carlo Method to Calculate an approximate solution and some of these are outlined in the following problems. Here describes more fuzzy optimization problems that do not have algorithms that give an exact fuzzy solution.

1. Fuzzy min-cost capacitated network
2. [10],[12],[16],[45].
3. Fuzzy shortest path problem [10],[12],[16],[38].
4. Fuzzy max –flow problem [10],[12],[16],[38].
5. Inventory control:
   i. Inventory Control: Known demand
   ii. [10],[12],[17],[18].
   iii. Inventory Control: Fuzzy Demand [12].
   iv. Inventory Control: Backordering
   v. [10],[12],[17],[18].
6. Fuzzy transportation problem [10],[45].
7. Fuzzy dynamic programming. [10].
8. Fuzzy PERT- project evaluation and review technique(Fuzzy Project Scheduling) [10],[45].
9. Max/Min Fuzzy function. [10].

About MATLAB:

MATLAB is a comprehensive software system for mathematics and technical computing. MATLAB is applicable to problems in Mathematics, Engineering, Economics, Physics and Psychology. A MATLAB accessary, SIMULINK is used for simulating dynamical processes.
MATLAB is an integrated technical computing environment that combines numeric computation, advanced graphics, visualization and high level programming language. That can communicate with FORTRAN and C. We can use it to graph functions, solve equations, perform statistical test and do much more. We can produce sound and animate graphics, also can do simulation and graphics. We can prepare materials for export to the World Wide Web. Also we can use MATLAB in conjunction with the Word processing and dextop publishing features of Microsoft Word, to combine mathematical computations with text and graphics to produce a polished, integrated, and interactive document for report presentation or online publishing.

MATLAB program sophisticated contains many features and options. There are hundreds of useful commands at our disposal. In one sentence MATLAB is an extremely useful and versatile tool [31], [33], [40].

CONCLUSION:

Future research could be involved with continuing to use our Fuzzy Monte Carlo Method on fuzzy linear programming problems. Particularly attacking above fuzzy optimization problems. Also look at those fuzzy optimization problems not given in above list that may be solved by Monte Carlo Method.

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