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Artificial Intelligence Based Metaheuristic Computational Approach for Solving Multi-Level Linear and Non-linear Programming Problems Using Fuzzy Genetic Algorithm.

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Abstract

Metaheuristics are the general search procedure whose principles allow them to escape the trap of local optimality using heuristic designs. There are many metaheuristics techniques already exist in the literature. In this paper we propose an artificial intelligence based metaheuristics computational approach for obtaining a satisfactory solution to a Multilevel liner and non-linear programming problem" with two decision makers (DMs) interacting with their optimal solutions to the formulated programming problems are obtained.

Keywords: Artificial intelligence, Metaheuristics approach, satisfactory solution, Multi-level linear and non-linear Programming problem, Optimal solution, fuzzy genetic algorithm,genetic algorithm.

[I] Introduction

Genetic algorithm was first introduced by Holland ,he introduced the concept of Adaptation of natural and artificial systems and since then it has been applied by different authors in many OR field.GA, which is a population based search technique it has been widely studied, experimented and applied in many fields in engineering worlds. Not only does GAs provide an alternate method to solving problem, it consistently outperforms other traditional methods in the most of the problem link. In general, GAs performs directed random searches through a given set of alternatives with the aim of finding the best alternative with respect to given criteria of goodness. These criteria are required to be expressed in terms of an objective function, which is usually referred to as fitness function. GA search for the best alternative (in the sense of a given fitness function) through 'chromosomes' evolution

Multi objective optimization techniques have been developed to permit a more faithful analysis of the tradeoffs among competing goals, and assist a planner in reaching an acceptable compromise. Multilevel mathematical programming problems, if carefully defined, can serve as useful tools in modelling structured economic units.

This paper has proposed a general mathematical structure for such problems, and specifically characterized the multi-level linear and non-linear programming problem by using fuzzy genetic algorithm.

[II] Artificial Intelligence

Artificial intelligence include game playing, expert systems, natural language, and robotics. The area may be subdivided into two main branches. The first branch, cognitive science, has a strong affiliation with psychology. The goal is here to construct programs for testing theories that describe and explain human intelligence[12]. The second branch, machine intelligence, is more computer science oriented and studies how to make computers behave intelligent. It doesn't matter whether or not the mental processes of humans are simulated as long as the constructed systems behave intelligent.

[III] Metaheuristic

Metaheuristics is a rather unfortunate1 term often used to describe a major subfield, indeed the primary subfield, of stochastic optimization[10,11]. Stochastic optimization is the general class of algorithms and techniques which employ some degree of randomness to find optimal (or as optimal as possible) solutions to hard problems. Metaheuristics are the most general of these kinds of algorithms, and are applied to a very wide range of problems.

Metaheuristics are applied to I know it when I see it problems. They're algorithms used to find answers to problems when you have very little to help you: you don't know beforehand what the optimal solution looks like, you don't know how to go about finding it in a principled way, you have very little heuristic information to go on, and brute-force search is out of the question because the space is too large. But if you're given a candidate solution to your problem, you can test it and assess how good it is. That is, you know a good one when you see it.

[IV] Fuzzy Genetic Algorithm

The Genetic Algorithm (GA), often referred to as genetic algorithms, was invented by John Holland at the University of Michigan in the 1970s[9]. It is similar to the (μ, λ) Evolution Strategy in many respects: it iterates through fitness assessment, selection and breeding, and population reassembly. The primary difference is in how selection and breeding take place: whereas Evolution Strategies select all the parents and then create all the children, the Genetic Algorithm little-by-little selects a few parents and generates a few children until enough children have been created [2]. To breed, we begin with an empty population of children. We then select two parents from the original population, copy them, cross them over with one another, and mutate the results. This forms two children, which we then add to the child population. We repeat this process until the child population is entirely filled. Here's the algorithm in pseudo code.

Genetic Programming (GP) is a research community more than a technique process. The community focuses on how to use stochastic methods to search for and optimize small computer programs or other computational devices. Note that to optimize a computer program, we must allow for the notion of suboptimal programs rather than programs which are simply right or wrong.GP is thus generally interested in the space where there are lots of possible programs (usually small ones) but it's not clear which ones outperform the others and to what degree. For example, finding team soccer robot behaviours, or fitting arbitrary mathematical equations to data sets, or finding finite-state automata which match a given language.

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Genetic Algorithm Applications

Genetic algorithms are inspired and based on the process of evolution by natural selection in order to provide solutions to real-world problems. Specifically, the genetic algorithm is applied in order to solve several optimization problems, like problems where the objective function is discontinuous, non-differentiable, stochastic, or highly nonlinear. The genetic algorithm(GA) can address problems of mixed integer programming, where several components are restricted to be integer-valued (Almeida, Oliveira, & Pinto, 2015). Furthermore, genetic algorithm (GA) are used solving complex search problems such as engineering to create incredibly high-quality products due to their ability to search a through a huge combination of parameters to find the best match. For instance, GA searches through different combinations of materials and designs to find the better combination in order to result in an overall enhanced result. Additionally, they are used to design computer algorithms, to schedule tasks, and to solve several optimization problems.

Genetic Algorithm-

In Artificial Intelligence

- Genetic Algorithm is one of the heuristic algorithms.
- They are used to solve optimization problems.
- They are inspired by Darwin's Theory of Evolution.
- They are an intelligent exploitation of a random search.
- Although randomized, Genetic Algorithms are by no means random.

[V] Algorithm-

Genetic Algorithm works in the following steps-

Step-01:

- Randomly generate a set of possible solutions to a problem.
- Represent each solution as a fixed length character string.

Step-02:

Using a fitness function, test each possible solution against the problem to evaluate them

Step-03:

- Keep the best solutions.
- Use best solutions to generate new possible solutions.

Step-04:

Repeat the previous two steps until-

- Either an acceptable solution is found
- Or until the algorithm has completed its iterations through a given number of cycles / generations.

[VI] Basic Operators-

The basic operators of Genetic Algorithm are-

1. Selection

- It is the first operator applied on the population.
- It selects the chromosomes from the population of parents to cross over and produce offspring.
- It is based on evolution theory of "Survival of the fittest" given by Darwin.

There are many techniques for reproduction or selection operator such as-

- Tournament selection
- Ranked position selection
- Steady state selection etc.

2. Cross Over-

- Population gets enriched with better individuals after reproduction phase.
- Then crossover operator is applied to the mating pool to create better strings.
- Crossover operator makes clones of good strings but does not create new ones.
- By recombining good individuals, the process is likely to create even better individuals.

3. Mutation-

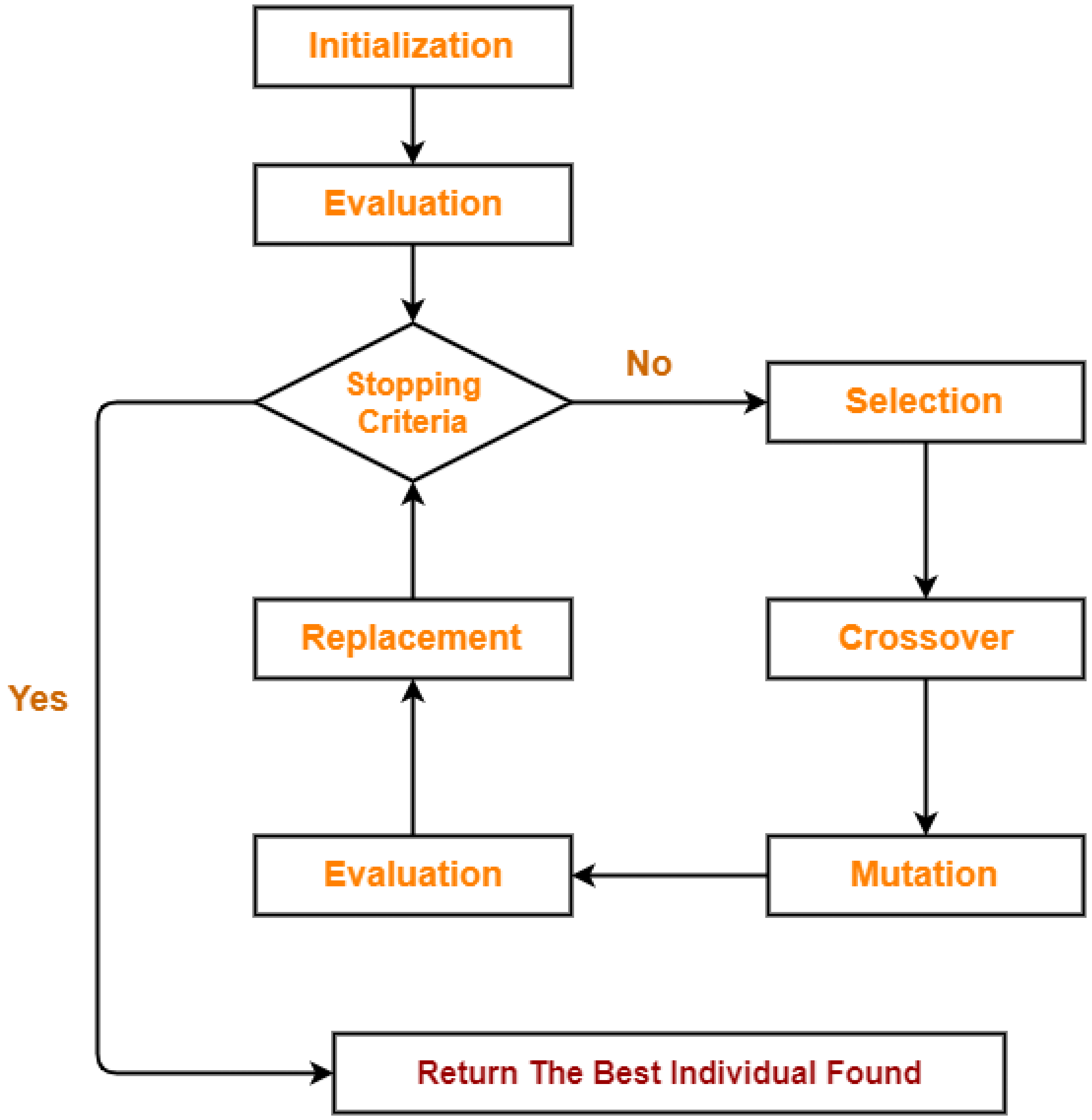
- Mutation is a background operator.
- Mutation of a bit includes flipping it by changing 0 to 1 and vice-versa.
- After crossover, the mutation operator subjects the strings to mutation.
- It facilitates a sudden change in a gene within a chromosome.
- Thus, it allows the algorithm to see for the solution far away from the current ones.
- It guarantee that the search algorithm is not trapped on a local optimum.
- Its purpose is to prevent premature convergence and maintain diversity within the population.

4. Evaluation

- Replacement
- Stop criteria
- Go to the individual fund

[VII] Flow Chart-

The following flowchart represents how a genetic algorithm works-



How Genetic Algorithm Works

Advantages-

Genetic Algorithms offer the following advantages-

- Genetic Algorithms are better than conventional AI.
- This is because they are more robust.
- They do not break easily unlike older AI systems.
- They do not break easily even in the presence of reasonable noise or if the inputs get change slightly.

While performing search in multi modal state-space or large state-space,

- Genetic algorithms has significant benefits over other typical search optimization techniques.

[IX] Conclusion:

Genetic algorithms, searching from a population of points, seem particularly suited to multi- objective optimization. Their ability to find global optima while being able to cope with discontinuous and noisy functions has motivated an increasing number of applications in engineering and related fields. The development of the MOGA is one expression of our wish to bring decision making into engineering design, in general, and control system design, in particular.

This paper proposed a new algorithm for solving Multi-Level Linear and Non-linear Programming Problems Using Fuzzy Genetic Algorithm.. Using genetic algorithms to solve linear and non linear programming problems helps in overcoming the difficulties associated with bi- level multi-objective programming problems as non-linearity, multi-modality and confliction between the upper and lower-level objectives.GA is a process of selection of the individuals in a population satisfying the criterion of the survival of fittest and evolving them. Selection operator based on alpha value is used in GA which is based on alpha cut of fuzzy logic.

The GA was reasonably sophisticated, permitting sexual reproduction within and between ecosystems, a sexual reproduction by both mutation and inversion, random mutation of offspring produced by both sexual and asexual reproduction, library calls to the complete chromosome of a previously evolved individual, and hill-climbing for the most fit offspring. A complete replacement strategy was used to evolve generations. While the results obtained for this extremely difficult forecasting problem are of remarkably high quality, one should bear in mind that this research is still in a preliminary stage. Our future research will study alternative configurations of the GA, its sensitivity to parameter values such as the mutation rate and the relative rates of sexual and asexual reproduction, and improved strategies for parameter selection in forecasting applications of this type.

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