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A Short Note on Novel, Original and Innovative Research Results and Findings: Hybrid Optimization Techniques in Manufacturing Environment

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The growing complexity of real world applications in the areas of engineering, management, computing, economics and science requires powerful optimization centered techniques and approaches. These approaches must be capable of solving difficult problems such as non-linear objective function with constraints optimization as well as uncertainty and incomplete representation and integration. The hybrid optimization approach provides a valuable alternative to traditional methods used in optimization, due to its ability to deal with difficult real world problems including non-linearity, noisy, incomplete or obscured information, constrained resources, and massive processing large amount of data. In these regard, traditional methods based on local optimization and sequential processing often perform poorly.

Significant Contributions

The optimization methods of hybrid and non-hybrid approaches proposed in this research successfully solved in finding best optimal solution for the fitness (objective) function, best feasible and realistic solution for the decision variables, and best CPU computational time. The main significant contribution of this research work is provided below.

1. A new modified function has been constructed called s-curve membership function for the fuzzy optimization problem of industrial production planning. This membership function is flexible enough to capture and describe vagueness factor in the technological coefficients of constraint in this problem. Moreover it is very convenient to the decision maker in selecting various vagueness values in the decision making process. As this has been discussed in [1-3]. Furthermore, it avoids degenerate problem in the optimization process due to nonlinearity characteristic.

2. The formulation of fitness (objective) function in this research work based on the linear programming problem of industrial production planning. Nevertheless, in real life situation the fitness (objective) function need not necessarily take the linear form. Therefore, in these studies, a non-linear fitness (objective) function of cubic form formulated based on previous literature on optimization problem solving. This is the first time this non-linear objective function used in this particular problem of industrial production planning. The major drawback of linear programming approach is, this methodology can routinely handle problems with thousands of linear constraints, but they are unable to tackle nonlinear objectives.

3. There are 15 types of hybrid and non-hybrid techniques, and approaches been applied in solving the non-linear fitness (objective) function with linear constrained optimization problem of industrial production planning that have not been effectively solve before. The main significant methods that contributed to the best optimal fitness (objection) function, best feasible decision variables and best computational CPU time are Hybrid Line Search with Genetic Algorithms, Hybrid Line Search with Simulated Annealing and Hybrid Line Search with General Pattern Search and Simulated Annealing.

4. In comparison, the hybrid optimization approaches are outperformed the non-hybrid and classical optimization techniques in producing a very high quality solution in the fitness (objective) function, decision variables and computational CPU time. The outstanding performance of hybrid methods provided in the form of tabulated intelligent performance analysis [4]. This performance analysis is very useful for the decision maker and implementer in selecting the best possible method for solving any non-linear problems of real world applications. This is a very strong recommendation for the future researchers in the area of operational research, soft computing and artificial intelligence.

5. Computational and simulation experiences have revealed the strength of exploitation, exploration and robustness of GA successfully incorporated with LS method to provide an outstanding result in this research work. Similarly, a novel optimization technique SA been successfully incorporated with LS in order to find an extremely good solution for the computational of CPU time as well as best optimum value for fitness (objective) function, as discussed in [5- 7]. In fact, this both hybridization approaches performed as a benchmark solution for the whole optimization problem of industrial production planning.

6. The most significant strength of GA and SA approaches are lies on their speedy convergence to the optimal solution when incorporated with LS and GPS methods. The major drawback of GPS and MADS methods is lies in their slow convergence character even though they are able to reach near optimal solution for the fitness (objective) function. On the other hand, the findings reveal us that GA, GPS, MADS and LS approaches alone could not able to succeed in providing an outstanding solution for the CPU computational run. This is the major drawback of these non-hybrid approaches as it mention in [8-10].

7. The author strongly claims that this is the first time 5 dimensional solutions have been introduced in the industrial production planning problems. They are fitness (objective) function (f), decision variables (x_i), level of satisfaction (), vagueness parameter () and computational time (CPU in seconds). This is one of the

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new original contributions to the body of the knowledge in the area of industrial engineering production planning.

In this research work, a genetic optimization tool called as genetic algorithm, direct search and simulated annealing toolbox in MATLAB been applied in solving optimization problems. This GA toolbox developed for MATLAB. This software is easy to use, practical, and efficient. It provides a platform for modeling, design, simulation with an interactive environment and associated with sophisticated graphical facility. The research findings are limited to the following computer and MATLAB® used: The Intel Pentium M 1.6 GHz, 512 MB RAM 40 GB HDD; Intel Pentium M 2.8 GHz, 256 MB DDR RAM 80 GB HDD and Math Works MATLAB® Version 2.2 (R2007b) has been utilized for the simulation, computational and plotting purposes.

Future Research Work

The integration of GA, SA, LS, MADS and GPS with other emerging technology such ant colony optimization (ACO), particle swarm optimization (PCO) and artificial immune system (AIS) could be another challenging research areas [11-13]. The combination of these emerging technologies may not only involve GA and SA as a helper to these three, but could result in the emerging technologies being able to assist GA and SA applications. Different combinations may offer us a fruitful result in intelligent optimization systems.

Overall, the knowledge generated from hybrid evolutionary and heuristic optimization over the last three decades has now become mature. The prospect of applying hybrid intelligent optimization techniques for practical applications is overwhelming. A considerable growth in the application of hybrid intelligent optimization, particularly in the field of industrial engineering, anticipated in the near future.

To the best of author's knowledge, this research work is among the first to apply hybrid line search with GA, hybrid line search with SA and hybrid line search with SA and GPS to the industrial production planning problems. Furthermore, in this research work there are no any global solutions available at this moment. Therefore, further work includes solving other types of nonlinear and complex multi-objective problems arise in real world situation, by considering other meta-heuristic techniques such as hybrid tabu search with ant colony and particle swarm optimization. In particular, construction-planning problems, product mix problem, inventory models (discount, demand and variable replenishment), design of electrical networks, mechanical components, and facility location in optimization formulated in crisp, fuzzy or fuzzy-stochastic environment.

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