

A Hybrid Particle Swarm Optimization Algorithm for Solving Optimization Problem

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Abstract—A Hybrid Particle Swarm Optimization (HPSO) has been presented for solving optimization problems. In this work, an efficient hybrid algorithm based PSO, called the Hybrid PSO (HPSO), for solving the classical optimization and optimisation problems based on engineering problems has been shown. In this paper, three bench mark classical constrained optimization problems and two well known engineering design optimization problems have been solved and the corresponding outcomes were verified with other known optimization methods. Finally, to study the performance of the proposed technique with other well known optimization techniques, a comparative result analysis has been made.

Keywords—Particle Swarm Optimization, Hybrid PSO, Constrained Optimization, Optimization Problem

I. INTRODUCTION

Usually, an optimization problem (constrained) can be depicted in the following way

Find v to optimize $f(v)$

Subject to $g_i(v) \leq 0 \quad i = 1, 2, \dots, m$

$$v_{i,\min} \leq v_i \leq v_{i,\max} \quad i = 1, 2, \dots, m$$

Where, the objective function $f: R^n \rightarrow R$ and the constraints $g_i: R^n \rightarrow R, i = 1, 2, \dots, m$. where $v_{i,\min}$ and $v_{i,\max}$ are the minimum and the maximum permissible values for the i^{th} vector respectively.

Collaborative behavior of biological populations Particle Swarm Optimization (PSO) was discovered by Kennedy and Eberhart [4] in the mid 1990s. In PSO, a set of randomly generated solutions propagates in the design space towards the optimal solution over a number of iterations (moves) based on large amount of information about the design space that is assimilated and shared by all members of the swarm. PSO is inspired by the ability of flocks of birds, schools of fish, and herds of animals to adapt to their environment, find rich sources of food, and avoid predators by implementing an “information sharing” approach.

This paper represents a new hybrid meta-heuristic algorithm, called HPSO to solve the problems based on optimization applications. By taking number of populations

as team and playing with PSO method yield the best population which again leads for further operations. This method is used to solve optimization problems.

2 PROPOSED HYBRID ALGORITHM

A hybrid meta-heuristic algorithm, viz. Hybrid Particle Swarm Optimization as HPSO has been introduced for solving well known optimization problems. In this algorithm, four different initial populations have been used and make a tournament over those populations to obtain the best stable initial population (best-initial). Tournament process has been applied between pair wise populations in different round of the tournament using PSO. After getting the best initial population once again PSO has been applied for maximum number of generations which finally yields the optimum solution.

2.1 Hybridization

Bhunia et al. (2008) proposed this Tournament [9] to develop genetic algorithm based hybrid algorithm (called tournament GA or TGA). Recently Bhunia and Samanta (2014) extended this idea by introducing an additional option to select the population of the next round. In this process, two different populations through random initialization are considered and then these are improved by applying GA and finally 50% of individuals taken from two improved populations. In this work, union of best 50% of each of the improved populations P_1' and P_2' are considered from the corresponding two populations P_1 and P_2 respectively in order to obtain the initial population P_{12} for the next round.

2.2 Particle Swarm Optimization (PSO)

PSO was originally invented by Kennedy and Eberhart [4, 15]. It exploits a population of search points. Each particle in PSO keeps track of its coordinates in the search space, which are associated with the best solution. This location is personal best (*pbest*). On the other hand, the location of a particle consisting of best fitness value is called the global best (*gbest*). Each particle moves its position in search domain and updates its velocity according to its own flying experience and neighbours flying experience toward its *pbest* and *gbest* locations.

To implement the PSO, the following basic elements are to be considered:

Particle: It is a potential solution represented by a vector.

Swarm: It is a population of moving particles where each particle seems to be moving in a random direction.

Particle best position:As a particle moves through the search space, it compares the fitness value at the current position to be best fitness value, it has ever attained at any time up to the current time.

Global best position: It is the best position among all individual best positions achieved so far.

Particle velocity: It is the velocity of the moving particles. According to the individual best and global best positions, the particle's velocity is updated. After obtaining the updated velocity, each particle position is changed to the next generation.

The search procedure of PSO algorithm is presented as follows:

Algorithm

Step-1:Initialize the PSO parameters and bounds of the decision variables of the optimization problem.

Step-2:Initialize a population of particles with random positions and velocities.

Step-3:Evaluate the fitness of each particle.

Step-4: Do the following steps until the stopping criterion is satisfied:

- Compare each particle's fitness with the particle's pbest. Store better one as pbest.
- Compare the current gbest position with earlier gbest position.
- Update the velocity of each particle using Eq. (1).
- Update the position of each particle using Eq. (2).

Step-5:Print the position and fitness of global best particle.

Step-6:End

3. EXPERIMENTAL RESULTS:

The performance of HPSO is verified with some benchmark optimization problems. Ten independent runs have been considered by this method. Here, the population size and maximum generation are taken as 50 and 20 respectively. The efficiency of HPSO has been verified with optimization problems and the corresponding results have been tested with other methods.

The algorithm was developed in C++ and all sort of calculations are performed on a machine with core-2 duo processor and 2.10 GHz in Linux environment. Results obtained from different classical constrained optimization problems are presented in different tables.

Table 1 Results obtained from different classical constrained optimization problems

Problems	Hess, 1973	Salkin, 1975	Schittkowski, 1987
Global Optimum	310	320	13.5909
Best	309.5	319	13.1742
Worst	307	318	12.1341
Average	308	318.4	12.9834
Standard Deviation	2.01×10^{-3}	4.16×10^{-4}	7.12×10^{-2}

Table2: Experimental Results for the *Tension/compression spring design Engineering problem* has been compared with the existing earlier research works

Method	Worst Case	Average Case	Best Case
GA	0.0193	0.0156	0.0117
PSO	0.0141	0.0123	0.0105
Proposed HPSO	0.0128	0.0112	0.0101

4. CONCLUSIONS

In this work a population based hybrid optimization technique, called Hybrid and Particle Swarm Optimization (HPSO). The basic ideas behind this concept are inspired from winning match of tournament. Like in the tournament winning match is considered as the best, in the same way here also by applying tournament the best initial population has been found. It has been observed that the proposed method shows better results than other methods in terms of different comparative parameters. It is very interesting that this method can be utilized for solving real world unconstrained and constrained optimization problems.

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