A Heuristic Particle Swarm Optimization

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ABSTRACT

A heuristic version of the particle swarm optimization (PSO) is introduced in this paper. In this new method called "The heuristic particle swarm optimization(HPSO)", we use heuristics to choose the next particle to update its velocity and position. By using heuristics , the convergence rate to local minimum is faster. To avoid premature convergence of the swarm, the particles are re-initialized with random velocity when moving too close to the global best position. The combination of heuristics and re-initialization mechanism make HPSO outperform the basic PSO and recent versions of PSO.

Categories and Subject Descriptors

I.2.8 [**Artificial intelligence**]: *Problem Solving, Control Methods, and Search*

General Terms

Algorithms, Experimentation, Performance.

Keywords

Heuristic, Particle Swarm Optimization.

1. INTRODUCTION

In the traditional PSO, all particles' positions and velocities are updated in a predefined order. In this manner, all particles have the same role. In our algorithm (HPSO), only the position and velocity of the best particle at the current time are updated. Moreover, we use small range of re-initialized random velocity to make HPSO good at fine-tuning the solution.

2. DESCRIPTION OUR APPROACH

The main idea of the HPSO is heuristic choosing the next particle, whose fitness value is the best at the current time. Suppose Next is its index:

$$f(X_{Next}) = Min\{f(X_i)\} \;\; i = 1,..,Npop \qquad (1)$$

$$V_{id} = \Phi_1 . r_1 . (\mathrm{P}_{id} - X_{id}) + \Phi_2 . r_2 . (\mathrm{G}_d - X_{id}) \qquad (2)$$

$$X_{id} = V_{id} + X_{id} \qquad (3)$$

If distance between a particle and the global best particle is smaller than the bounded factor λ then particle's velocity will be re-initialized randomly in range [$D_{\min}$, $D_{\max}$], where $\lambda = 10^{-8}$ as in the GPSO [1], and $D_{\max}$=0.1, $D_{\min}$=- 0.1 instead of $D_{\max} = V_{\max}$, $D_{\min} = V_{\min}$.

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To update particles' velocity and position we use formulae as in the traditional PSO, but we don't use old velocity in formula updating velocity. In these formulae Φ_1 and Φ_2 start at 2.25 and decrease to 2.0 at the end. Pseudo-code of the HPSO is shown in the picture 1.

$t \leftarrow 1$

Swarm's initialization

While ($t \le MaxIter * Npop$)

  Choose next particle: using (1)

  If (Distance(X_{Next} ,gbestposition) $\le \lambda$)

    $V_{Next,j} \leftarrow random(D_{\max}, D_{\min}) \;\; \forall j = 1,..,d$

  else

    Update velocity: using (2)

    Limit velocity in range [$-V_{\max}$, $V_{\max}$]

  Update position: using (3)

  Fitness Function evaluation: $f(X_{Next})$

  Personal best: pbest $\leftarrow f(X_{Next})$ if pbest > $f(X_{next})$

  Global best: gbest $\leftarrow f(X_{Next})$ if gbest > $f(X_{Next})$

Picture 1: Pseudo-code of the HPSO

3. EXPERIMENTAL RESULTS

The experimental results of HPSO are compared with the basic PSO (BPSO) and the gregarious PSO (GPSO) [1]. According to [1] GPSO outperforms many versions of PSO. All the seven test problems and their parameters, as well as all the parameters of GPSO, BPSO are chosen as described in [1]. The obtained optimum values and standard deviations are shown in the table 1. According to the table 1, HPSO outperforms the basic PSO in almost test cases and the GPSO in the test cases with multimodal functions (Rastrigin, Griewank, Ackley).

Table 1: Average optimum value and standard deviation (in brackets) at the end of 200000 function evaluations in 100 times running.

Fun	HPSO	GPSO	BPSO
Sphere	**0** (0)	**0** (0)	**0** (0)
Rosen.	**30.63** (29.46)	**2.21** (6.79)	**119.69** (261.31)
Rastrigin	**0** (0)	**0.059** (0.23)	**29.41** (7.46)
Griewank	**0.007** (0.008)	**0.059** (0.05)	**0.017** (0.019)
Ackley	**1E-7** (1E-7)	**0.21** (1.69)	**3.22** (7.38)
Schaffer's	**0.004** (0.004)	**0.004** (0.004)	**0** (0)
Shekel's	**0.998004** (0)	**0.998004** (0)	**0.998004** (0)

4. REFERENCES:

[1] Srinivas Pasupuleti and Roberto Battiti, "The Gregarious Particle Swarm Optimizer (GPSO)", GECCO 2006.

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