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International Journal of Research Publications

HIDE : Human Inspired Differential Evolution – An Algorithm under Artificial Human Optimization Field

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Abstract

Artificial Human Optimization is a new field that came into existence on December 2016. All the optimization algorithms that were created and are being created based on Artificial Humans will come under Artificial Human Optimization Field. Just like agents in Ant Colony Optimization are Artificial Ants, agents in Bee Colony Optimization are Artificial Bees, agents in Genetic Algorithms are Artificial chromosomes, agents in Particle Swarm Optimization are Artificial Birds or Artificial Fishes, similarly agents in Artificial Human Optimization Algorithms are Artificial Humans. "Multiple Strategy Human Optimization (MSHO)" is a new algorithm designed recently based on Artificial Humans. The key concept in MSHO is to use more than one strategy in the optimization process. Two strategies are used in MSHO. One strategy is to move towards the best individual in one generation. Another strategy is to move away from the worst individual in next generation. Differential Evolution is a popular algorithm for solving optimization problems in various domains. In this paper "Human Inspired Differential Evolution (HIDE)" is proposed. The idea of HIDE algorithm is to use the concept of Multiple Strategies of MSHO algorithm in Differential Evolution. The mutation operator of Differential Evolution algorithm is modified to incorporate the key concept of MSHO algorithm in Differential Evolution. The proposed HIDE algorithm is tested by applying it on a complex benchmark problem.

Keywords: Artificial Humans; Artificial Human Optimization; Differential Evolution; Genetic Algorithms; Particle Swarm Optimization; Ant Colony Optimization; Artificial Bee Colony Optimization; Bio-Inspired Computing; Nature Inspired Computing; Artificial Intelligence; Machine Learning; Global Optimization Techniques; Evolutionary Computing

1. Introduction

In [1], Artificial Human Optimization (AHO) was introduced. 10 plus reviews on work in AHO field were shown in [2]. A new algorithm titled “POSTDOC : The Human Optimization” was designed in [3]. In [4], an Introduction to AHO field was given. Ocean of opportunities in Artificial Human Optimization Field was shown in [5]. According to [5], millions of papers are possible in AHO Field. 25 reviews from experts on work under AHO field were given in [6]. 30 plus abstracts of papers in Artificial Human Optimization Field were shown in [7]. The first paper in Artificial Human Optimization Field was proposed in 2006 [8]. In [4], Multiple Strategy Human Optimization (MSHO) was proposed. A new mutation operator based on worst and best individuals of particular generation was proposed in [9] and [10]. In [11], the decision-making behavior of Human Society was simulated. But [9], [10], [11] use same strategy for mutation across all generations. The idea of this experiment in this paper is to incorporate the key concept of MSHO which is multiple strategies across generations into DE. Hence Human Inspired Differential Evolution (HIDE) is proposed in this paper. HIDE uses best and worst individuals in mutation operators similar to work in [9] and [10]. It also uses more than one strategy across generations like Multiple Strategy Human Optimization designed in [4] and unlike work in [9] and [10] where same mutation strategy was used across all generations.

2. Differential Evolution

This section explains Differential Evolution method. Differential Evolution Algorithm is shown in section three. The population is initialized randomly. There are 3 operations in Differential Evolution. They are mutation, crossover and selection. In mutation 3 individual vectors which are different and different from target vector are selected. Two individuals are subtracted to get difference vector. The difference vector is scaled by factor F and then it is added to the base vector to obtain donor vector. Crossover probability CR is present in crossover operation. A random number is generated and if it is less than or equal to crossover probability then the dimension from donor vector is selected and if generated random number is greater than crossover probability then the dimension from target vector is selected. This process of selecting dimensions from donor vector or target vector is repeated for all the dimensions to obtain trial vector. In selection operator, the fitness of trial vector and target vector are compared and best fitness value individual is selected from both. The selected individual is moved to next generation. This process of mutation, crossover and selection is repeated for all individuals in the population to get next generation individuals.

3. Human Inspired Differential Evolution Algorithm (HIDE Algorithm)

This section explains Human Inspired Differential Evolution Algorithm. This section shows Human Inspired Differential Evolution Algorithm. The difference between Differential Evolution and Human Inspired Differential Algorithm lies in mutation operator. In generation G =0 and even generations the mutation operator is different to mutation operator in odd generations. The different mutation strategies in different generations are incorporated to bring the key concept of “Multiple Strategy Human Optimization (MSHO)” (which comes under Artificial Human Optimization) into Differential Evolution Algorithm. With the incorporation of different strategies in even and odd generations, the modified Differential Evolution algorithm is created. This new modified method is given a name "Human Inspired Differential Evolution (HIDE)". The mutation operator in HIDE algorithm is shown below:

1) **If (** generation G is even || generation G is 0 **) then**
/* Moving towards the best individual in
starting generation and even generations
*/
2) $u_{i,j} = X_{best,j} + F * (X_{b,j} – X_{c,j})$ // Mutation operator for G =0 or G = even
3) **else**
/* Moving away from the worst individual in
odd generations
*/
4) $u_{i,j} = X_{a,j} + F * (X_{b,j} – X_{worst,j})$ // Mutation operator for G = odd
5) **end if**

Differential Evolution Algorithm is shown below:
Procedure : Differential Evolution
1) **begin**
2) Set generation count G = 0.
Initialize population randomly for NP individuals.
Initialize parameters CR and F.
3) Calculate fitness for all individuals in the population.
4) **while (**termination condition not equals to true**) do**
5) **for (** i = 1 to NP**) do**
6) Select 3 individuals X_a, X_b and X_c such that
7) $X_i != X_a != X_b != X_c$
8) **for (** j = 1 to D **) do**
9) select jrand randomly from 1 to D
10) randno= rand(0,1)
11) **if (** randno <= CR or j == jrand **) then**
12) $u_{i,j} = X_{a,j} + F * (X_{b,j} – X_{c,j})$
13) **else**
14) $u_{i,j} = X_{i,j}$
15) **end if**
16) **end for**
17) **end for**
18) **for (** i = 1 to NP **) do**
19) calculate u_i
20) **if (**u_i is better than X_i **) then**
21) $X_i = u_i$
22) **end if**
23) **end for**
24) Store the best solution achieved so far.
25) **end while**
26) **end**

Human Inspired Differential Evolution algorithm is shown below:

Procedure : Human Inspired Differential Evolution (HIDE)

```
begin
Set generation count G = 0.
  Initialize population randomly for NP individuals.
  Initialize parameters CR and F.
Calculate fitness for all individuals in the population.
    while (termination condition not equals to true) do
        for ( i = 1 to NP) do
            Select 3 individuals X_a, X_b and X_c such that
            X_i != X_a != X_b != X_c
            for ( j = 1 to D ) do
                select jrand randomly from 1 to D
                randno= rand(0,1)
                if ( randno <= CR or j == jrand ) then
                    If ( generation G is even || generation G is 0 ) then
                        /*
                         Moving towards the best individual in starting
                        generation and even generations
                        */
                        u_i,j = X_best,j + F * (X_b,j – X_c,j)
                    else
                        /*
                         Moving away from the worst individual in odd
                        generations
                        */
                        u_i,j = X_a,j + F * (X_b,j – X_worst,j)

                    end if
                else
                    u_i,j = X_i,j
                end if
            end for
        end for
        for ( i = 1 to NP ) do
            calculate u_i
            if (u_i is better than X_i ) then
                X_i = u_i
            end if
        end for
        Store the best solution achieved so far.
    end while
end
```

4. Application of proposed HIDE Algorithm on Ackley Function 3D

The proposed HIDE algorithm is applied on very complex function with many local minima, local maxima. Ackley Function 3D and it's equation [12] is shown in Figure 1 and Figure 2 below. Figures of Ackley Function 3D are taken from [12]:

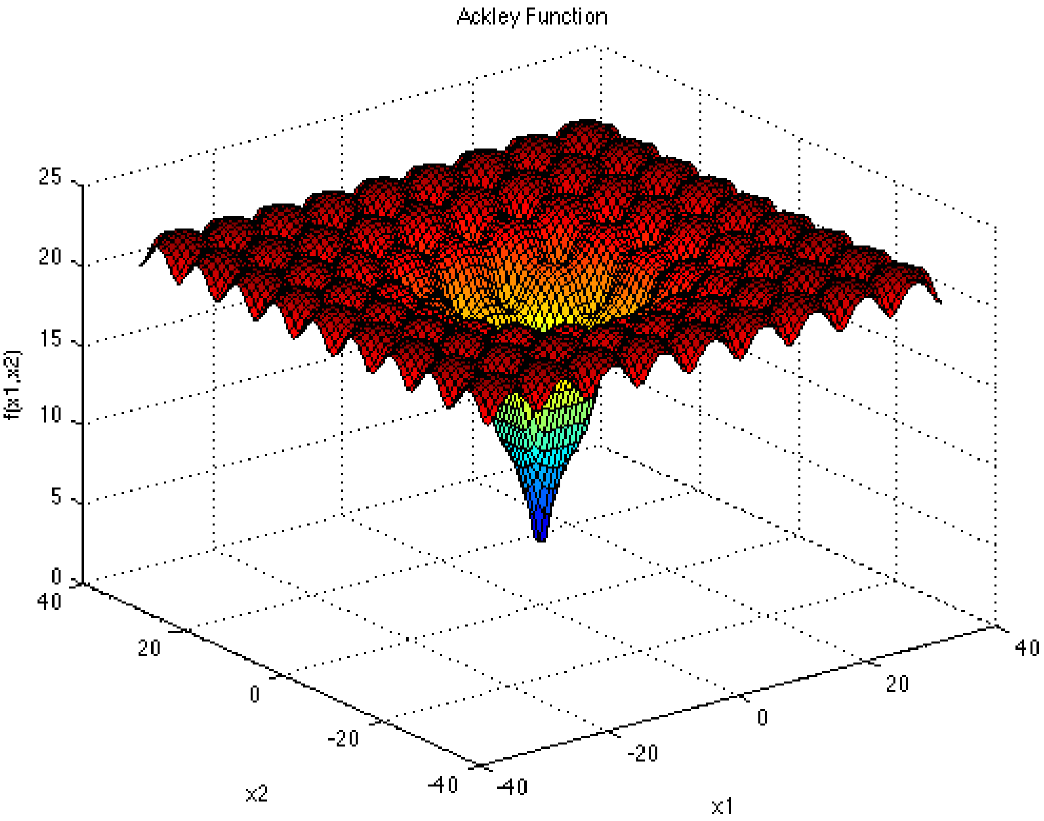

Figure 1. Ackley Function 3D

$$f(\mathbf{x}) = -a \exp\left(-b\sqrt{\frac{1}{d}\sum_{i=1}^{d} x_i^2}\right) - \exp\left(\frac{1}{d}\sum_{i=1}^{d}\cos(cx_i)\right) + a + \exp(1)$$

Figure 2. Equation of Ackley Function

From Figure 3 it is clear that HIDE Algorithm gave solution which is very close to (0, 0, 0) which is global optimum of Ackley 3D Function. Hence for this particular parameters setting (Population = 100, generations = 800, scale F = 0.9, Crossover probability = 0.2, range for individuals for each dimension = [-100 100]), the proposed HIDE algorithm performed well.

Figure 3. Solution given by HIDE algorithm

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