Testing Multiple Strategy Human Optimization based Artificial Human Optimization Algorithms

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Note

This article is in review for publication in another journal. This article is submitted for re-publication in this journal in an attempt to popularize "Artificial Human Optimization" Field like never before. The First Author of this paper (Satish Gajawada) is completely responsible for this action of re-publication.

Abstract

Recently a new trend titled 'Artificial Human Optimization' has become popular in Evolutionary Computing Domain. More than 30 papers were published in this new field proposed in December 2016. 'Hassan Satish Particle Swarm Optimization (HSPSO)' and 'Human Inspired Differential Evolution (HIDE)' are the two latest Artificial Human Optimization algorithms proposed based on Multiple Strategy Human Optimization. In this paper we focus on Testing HSPSO and HIDE by applying these latest algorithms on Ackley, Bohachevsky, Booth, Three-Hump Camel and Beale benchmark functions. Results obtained for these Artificial Human Optimization Algorithms are compared with Differential Evolution and Particle Swarm Optimization.

Indexing terms/Keywords: Artificial Humans, Global Optimization Techniques, Artificial Human Optimization, Nature Inspired Computing, Bio-Inspired Computing, Genetic Algorithms, Particle Swarm Optimization, Differential Evolution, Evolutionary Computing

Introduction

In [1], Multiple Strategy Human Optimization (MSHO) was proposed. In MSHO, more than one strategy are used for movement of Artificial Humans in search space. Artificial Humans move towards the best in even generations and move away from the worst in odd generations. In [2], Human Inspired Differential Evolution (HIDE) was proposed based on the concepts of MSHO and Differential Evolution. MSHO concepts are incorporated into Particle Swarm Optimization to create Hassan Satish Particle Swarm Optimization (HSPSO) [3]. But these algorithms are not completely tested. In this paper, HIDE and HSPSO are tested by applying these latest algorithms on various benchmark functions. Section 2 shows HSPSO algorithm. HIDE algorithm is shown in Section 3. Section 4 shows results obtained after applying HIDE and HSPSO on benchmark functions. Section 5 shows the conclusion.

2. Hassan Satish Particle Swarm Optimization (HSPSO)

Procedure: Hassan Satish Particle Swarm Optimization (HSPSO)

1) Initialize all particles
2) iterations = 0
3) **do**
4) **for** each particle i **do**
5) **If** (f(x_i) < f($pbest_i$)) **then**
6) $pbest_i = x_i$
7) **end if**

```
8)              if ( f( pbest_i ) < f( gbest ) ) then
9)                      gbest = pbest_i
10)             end if
11)             If ( f( x_i ) > f( pworst_i ) ) then
12)                     pworst_i = x_i
13)             end if
14)             if ( f( pworst_i ) > f( gworst ) ) then
15)                     gworst = pworst_i
16)             end if
17)     end for
18)     If ((iterations == 0) || (iterations%2==0)) then // for starting and even iterations
19)             for each particle i do
20)                     for each dimension d do
21)                         v_i,d = v_i,d + C1*Random(0,1)*(pbest_i,d – x_i,d) + C2*Random(0,1)*(gbest_d – x_i,d)
22)                         x_i,d = x_i,d + v_i,d
23)                     end for
24)             end for
25)     else // for odd iterations
26)             for each particle i do
27)                     for each dimension d do
28)                         v_i,d = v_i,d + C1*Random(0,1)*( x_i,d - pworst_i,d ) + C2*Random(0,1)*( x_i,d - gworst_d)
29)                         x_i,d = x_i,d + v_i,d
30)                     end for
31)             end for
32)     end if
33)     iterations = iterations + 1
34) while ( termination condition is false)
```

3. Human Inspired Differential Evolution (HIDE)

Procedure : Human Inspired Differential Evolution (HIDE)

```
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)                                     If ( generation G is even || generation G is 0 ) then
                                                /*
                                                 Moving towards the best individual in starting generation
                                                and even generations
                                                */
```

```
14)                                         u_{i,j} = X_{best,j} + F * (X_{b,j} – X_{c,j})
15)                                 else
                                            /*
                                             Moving away from the worst individual in odd generations
                                            */
16)                                         u_{i,j} = X_{a,j} + F * (X_{b,j} – X_{worst,j})
17)
18)                                 end if
19)                         else
20)                                 u_{i,j} = X_{i,j}
21)                         end if
22)                 end for
23)         end for
24)         for ( i = 1 to NP ) do
25)                 calculate u_i
26)                 if (u_i is better than X_i ) then
27)                         X_i = u_i
28)                 end if
29)         end for
30)         Store the best solution achieved so far.
31)     end while
32) end
```

4. Results

Results obtained after applying HSPSO and HIDE algorithms on various benchmark functions are shown in this section. The figures and equations of benchmark functions are taken from [4].

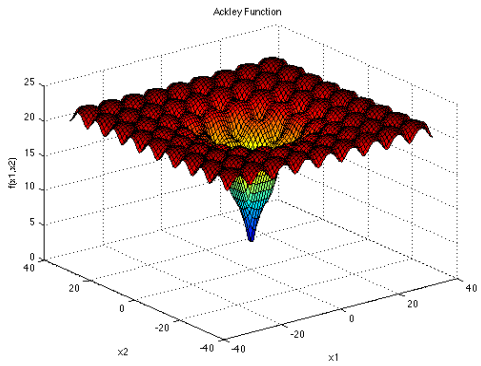

Figure 1 Ackley Function

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

Figure 2 Equation of Ackley Function

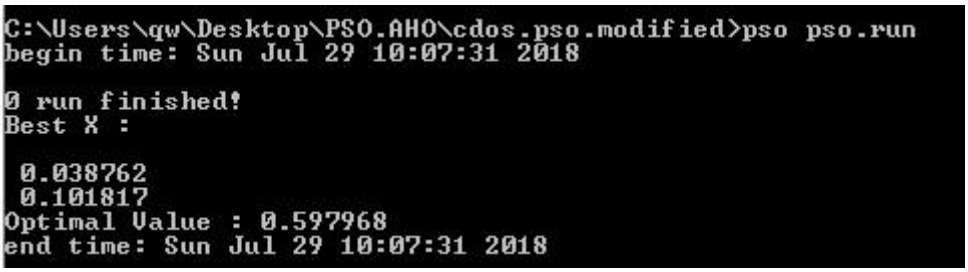

Figure 3 Result given by HSPSO on Ackley Function

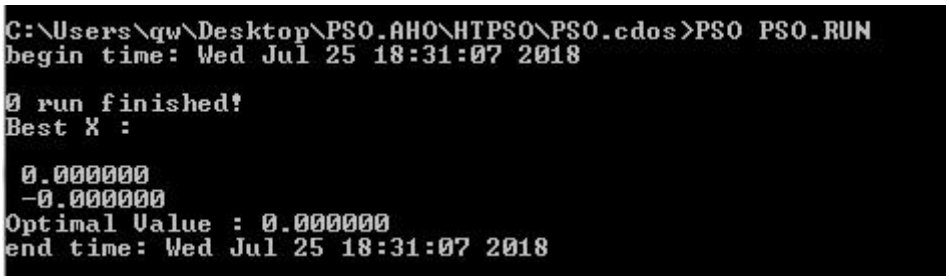

Figure 4 Result given by PSO on Ackley Function

From Figure 3 and Figure 4 it can be seen that PSO performed better than HSPSO on Ackley function.

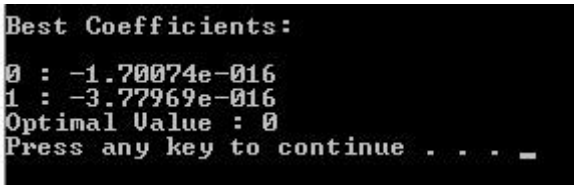

Figure 5 Result given by HIDE on Ackley Function

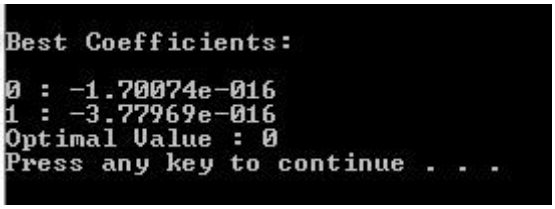

Figure 6 Result given by DE on Ackley Function

From Figure 5 and Figure 6 it can be seen that HIDE and DE performed equally well on Ackley function.

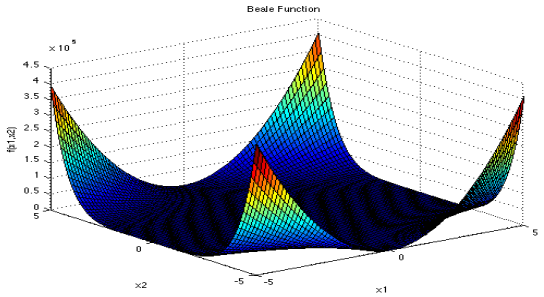

Figure 7 Beale Function

$$f(\mathbf{x}) = (1.5 - x_1 + x_1 x_2)^2 + (2.25 - x_1 + x_1 x_2^2)^2 + (2.625 - x_1 + x_1 x_2^3)^2$$

Figure 8 Equation of Beale Function

```
C:\Users\qw\Desktop\PSO.AHO\cdos.pso.modified>pso pso.run
begin time: Sun Jul 29 10:11:51 2018

0 run finished!
Best X :

 2.950198
 0.485876
Optimal Value : 0.000469
end time: Sun Jul 29 10:11:51 2018
```

Figure 9 Result given by HSPSO on Beale Function

```
C:\Users\qw\Desktop\PSO.AHO\HTPSO\PSO.cdos>PSO PSO.RUN
begin time: Wed Jul 25 18:34:03 2018

0 run finished!
Best X :

 3.000000
 0.500000
Optimal Value : 0.000000
end time: Wed Jul 25 18:34:03 2018
```

Figure 10 Result given by PSO on Beale Function

From Figure 9 and Figure 10 it can be seen that PSO and HSPSO both performed well on Beale function.

```
Best Coefficients:

0 : 3
1 : 0.5
Optimal Value : 0
Press any key to continue . . .
```

Figure 11 Result given by HIDE on Beale Function

```
Best Coefficients:

0 : 3
1 : 0.5
Optimal Value : 0
Press any key to continue . . .
```

Figure 12 Result given by DE on Beale Function

From Figure 11 and Figure 12 it can be seen that HIDE and DE performed equally well on Beale function.

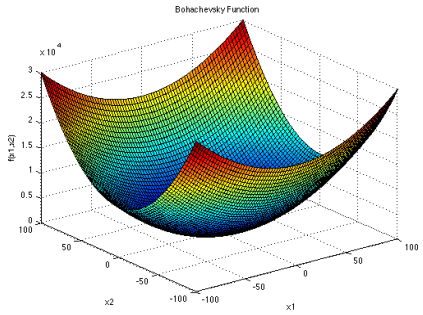

Figure 13 Bohachevsky Function

$$f_1(\mathbf{x}) = x_1^2 + 2x_2^2 - 0.3\cos(3\pi x_1) - 0.4\cos(4\pi x_2) + 0.7$$

Figure 14 Equation of Bohachevsky Function

```
C:\Users\qw\Desktop\PSO.AHO\cdos.pso.modified>pso pso.run
begin time: Sun Jul 29 10:16:59 2018

0 run finished!
Best X :

 0.620121
 0.056801
Optimal Value : 0.516828
end time: Sun Jul 29 10:16:59 2018
```

Figure 15 Result given by HSPSO on Bohachevsky Function

```
C:\Users\qw\Desktop\PSO.AHO\HTPSO\PSO.cdos>PSO PSO.RUN
begin time: Wed Jul 25 18:37:40 2018

0 run finished!
Best X :

 -0.000014
  0.000002
Optimal Value : -0.000000
end time: Wed Jul 25 18:37:40 2018
```

Figure 16 Result given by PSO on Bohachevsky Function

From Figure 15 and Figure 16 it can be seen that PSO performed better than HSPSO on Bohachevsky Function

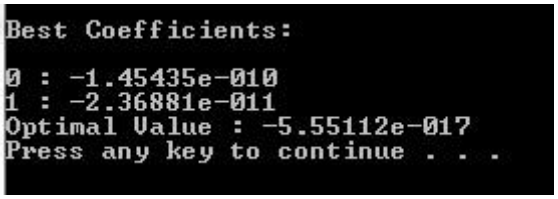

Figure 17 Result given by HIDE on Bohachevsky Function

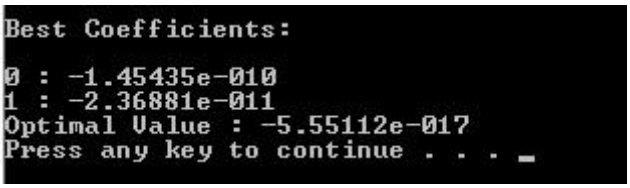

Figure 18 Result given by DE on Bohachevsky Function

From Figure 17 and Figure 18 it can be seen that HIDE and DE both performed equally well on Bohachevsky Function.

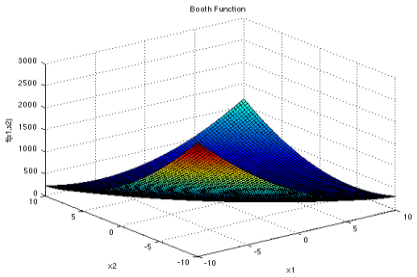

Figure 19 Booth Function

$$f(\mathbf{x}) = (x_1 + 2x_2 - 7)^2 + (2x_1 + x_2 - 5)^2$$

Figure 20 Equation of Booth Function

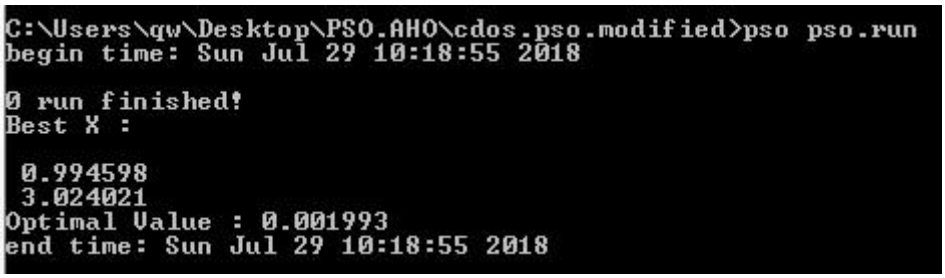

Figure 21 Result given by HSPSO on Booth Function

```
C:\Users\qw\Desktop\PSO.AHO\HTPSO\PSO.cdos>PSO PSO.RUN
begin time: Wed Jul 25 18:40:33 2018

0 run finished!
Best X :

 1.000000
 3.000000
Optimal Value : 0.000000
end time: Wed Jul 25 18:40:33 2018
```

Figure 22 Result given by PSO on Booth Function

From Figure 21 and Figure 22 it can be seen that HSPSO and PSO both performed well on Booth Function.

```
Best Coefficients:

0 : 1
1 : 3
Optimal Value : 0
Press any key to continue . . .
```

Figure 23 Result given by HIDE on Booth Function

```
Best Coefficients:

0 : 1
1 : 3
Optimal Value : 0
Press any key to continue . . .
```

Figure 24 Result given by DE on Booth Function

From Figure 23 and Figure 24 it can be seen that HIDE and DE both performed equally well on Booth Function.

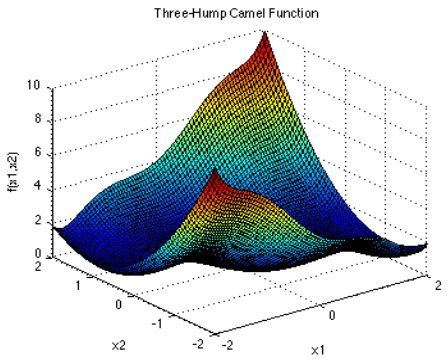

Figure 25 Three-Hump Camel Function

$$f(\mathbf{x}) = 2x_1^2 - 1.05x_1^4 + \frac{x_1^6}{6} + x_1x_2 + x_2^2$$

Figure 26 Equation of Three-Hump Camel Function

```
C:\Users\qw\Desktop\PSO.AHO\cdos.pso.modified>pso pso.run
begin time: Sun Jul 29 10:20:44 2018

0 run finished!
Best X :

 -0.008841
 -0.034073
Optimal Value : 0.001618
end time: Sun Jul 29 10:20:44 2018
```

Figure 27 Result given by HSPSO on Three-Hump Camel Function

```
C:\Users\qw\Desktop\PSO.AHO\HTPSO\PSO.cdos>PSO PSO.RUN
begin time: Wed Jul 25 18:44:40 2018

0 run finished!
Best X :

 0.000000
 0.000000
Optimal Value : 0.000000
end time: Wed Jul 25 18:44:40 2018
```

Figure 28 Result given by PSO on Three-Hump Camel Function

From Figure 27 and Figure 28 it can be seen HSPSO and PSO both performed well on Three-Hump Camel Function

```
Best Coefficients:

0 : -1.02145e-162
1 : 1.19657e-162
Optimal Value : 0
Press any key to continue . . .
```

Figure 29 Result given by HIDE on Three-Hump Camel Function

```
Best Coefficients:

0 : -1.02145e-162
1 : 1.19657e-162
Optimal Value : 0
Press any key to continue . . .
```

Figure 30 Result given by DE on Three-Hump Camel Function

From Figure 29 and Figure 30 it can be seen that HIDE and DE both performed equally well on Three-Hump Camel Function

Conclusion

Human Inspired Differential Evolution (HIDE) and Differential Evolution (DE) performed equally on all benchmark functions. Particle Swarm Optimization (PSO) performed better than Hassan Satish Particle Swarm Optimization (HSPSO) on 2 benchmark functions. HSPSO and PSO both performed well on remaining benchmark functions.

References

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